THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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ELECTRICAL CONTRACTORS AND THEIR RIGHTS.

MR. R. TWEEDY SMITH, hon. solicitor to the L.E.C.A., read a paper on the 3rd inst., before the Association, entitled "The Rights, Duties, and Liabilities of Electrical Contractors under the Electric Lighting and other Acts." Whilst Mr. Tweedy Smith has evidently obtained a thorough grasp of the whole question, he is, perhaps, naturally biassed in the contractors' interests. The paper, which, unfortunately, we have not space to print in full, deals chiefly with the grievances of contractors under the Acts, and particularly with the want of uniformity in the rules and tests issued and required by station engineers. There is no doubt that he made out a strong case; we are, of course, all familiar with the many anomalies and disabilities under which the wiring trade and others have to work, and whilst these are largely due to the fault of Parliament in the early days of electric lighting, and to the personal element associated with every undertaking and every specification, which not even the rules of the I.E.E. have entirely abolished, a further cause must be looked for amongst contractors themselves.

The wiring industry has been built up in such a peculiar way that insufficient attention has been drawn to its growing importance, and to the necessity of employing skilled, competent workmen. As a result, consulting and station engineers have had to protect themselves, their clients, and their undertakings against inferior work. Had there been an opportunity in the early days to properly define an electrical contractor and his work, and had the trade then taken up the question of an examination and the awarding of certificates, many of the present inconveniences and disabilities would not be existing.

Whilst we have every sympathy with the objects of the Association, believing that they have it in their power to bring about such a state of things as suggested, however belated this may be, and also that the existence of such a body will be to the benefit of the trade generally, it would nevertheless be a pity if the members failed to see that where customs have taken deep root they cannot be overthrown in a day. It is quite easy to understand the Association's position; its members have only recently combined, after years of the keenest competition. They are now looking to "getting some of their own back," and in this many will wish them success. But it will not be done by ignoring the station engineers, who, after all, are the contractors' best friends, for their whole object is to get as many connections as possible consistent with work that will give satisfaction to the consumers and no trouble to the undertaking. Therefore, the best advice that can be given to the contractors is to follow strictly the lines of their motto: *suaviter in modo, fortiter in re*, with special regard to the first part. It is for them to co-operate with the station engineer and the consulting engi-

neer, and not to threaten those who have it in their power to further the contractors' interests, especially in view of the many "free wiring" schemes which may be taken in hand. If they adopt a conciliatory attitude with the knowledge that in all negotiations there must be a certain amount of give and take, it is certain that their objects will be more quickly attained than would otherwise be the case.

The McMillan Memorial Fund.

THE great and irreparable loss which the Institution of Electrical Engineers has sustained through the sad death of its late secretary, is acknowledged on all hands; it must not be forgotten, however, that the Institution's loss is in no way comparable with that sustained by his wife and young children. Acting independently of each other, many members arrived at the conclusion that their sympathy towards Mrs. McMillan might well take the practical form of a fund to be eventually placed at her disposal. This being so, the announcement of the President, Mr. R. K. Gray, at the last meeting of the Institution, makes an urgent claim upon the practical sympathies of all connected with the Institution.

The President, after referring to Mr. McMillan's death, stated that, unfortunately, as an Institution, they were unable to deal with the matter financially as they would wish to do, and therefore the Council had decided to invite members of the Institution to create a fairly large fund by means of private subscriptions. The Council had done all it could in other ways.

Sir Henry Mance (Past-President) submitted a resolution of condolence as follows:—

That the members of the Institution of Electrical Engineers in full meeting, desire to express their profound sorrow at the death of the late Secretary, Mr. Walter George McMillan, and to put on record their high appreciation of his personal character and those qualities which, as a scientific man and as an administrator, had contributed so much to the prosperity of the Institution; and also to express to Mrs. McMillan and other members of the family their heartfelt sympathy under this sudden calamity.

Prof. John Perry (Past-President), in seconding the resolution, referred to the Christian life which was a characteristic of their late Secretary, and to his exceptional hard working qualities. He believed that Mr. McMillan, with his great capacity for work, had overworked himself, but the blow to his family would be lessened by the knowledge that he had earned the respect and gratitude of the Institution.

The President remarked that it was absolutely unnecessary to put the resolution to the meeting. They hoped to obtain a sum of £2,000 for the fund, and amounts already contributed had been handed over to the Council. We are glad to learn that there is to be only *one* fund; as we have already said no other course could possibly bring about so good a result. It now remains for our readers to give the best evidence they can of their gratitude, sympathy and liberality by readily and generously responding to the President's appeal.

Motor Hire and Hire-Purchase Systems.

THESE subjects were discussed by Mr. Sidney E. Britton, burgh electrical engineer of Motherwell, in a paper which he read before the Glasgow Local Section of the I.E.E. on the 9th inst. The actual manner of introduction was by way of an interrogative, the paper being entitled, "Should Electric Supply Undertakings Advance Motors on Hire or Hire-Purchase systems?"

Mr. Britton stated at the outset that he had been warned of the consequences of introducing such a subject in Glasgow, but he was evidently quite fearless of the results, showing his independence by telling the second city that the scheme had not been understood. No doubt the remark is true that a large city, containing many wealthy manufacturers, does not need that stimulus to its supply that a small town does. Nevertheless, in a large city there are a great many more small manufacturers than in a small one, as this class generally herd together thickly in certain streets and districts. The author stated also that he had tried to give neither side the preference in his paper, although he was inclined to favour the "cons;" in the latter respect we think that no sensible person will disagree with him on the principle involved. It is in the manner in which this is carried out that opinions may differ, and this, of course, raises the whole question of municipal trading, which Mr. Britton skilfully skimmed round. But we cannot agree with him in the suggestion that the great majority of the objectors are those who make poor or foreign motors. This may be so to a limited extent, due to failure to do business with engineers, but we think the chief objection is inspired by the fear that corporations, having no incentive to dividends, may not manage the business so well as private undertakings. Assuming, however, that all is as it should be, it remains only for the authority to decide whether it will take up hire, or hire-purchase, or both; and whether in the payment, repairs and renewals are to be included or not. We think Mr. Britton throws his opinion on the right side by stating that the inclusion of renewals and repairs is speculative, and does not encourage the consumer to give that care to his motor that he otherwise would do.

The whole future of the success of the electric supply undertakings of the country is wrapped up in the securing of a good day load, and as the purchase out right of motors by the small consumers is out of the question, owing to the expense involved, it is only by some such system as those discussed that their more universal employment can be brought about. Of course, this does not apply to residential districts, where the call for motors is small; but the question of day load is everywhere the same, and we think, therefore, that the question of electric heating and cooking should be considered *pari passu* with that of motors. It is only necessary to point out the success of the gas companies in this direction to show that the hire or hire-purchase system is no mere experiment. But electric supply authorities should not rest content with obtaining the necessary permission (we speak of municipalities for the moment). The consumers will not come to them. What is wanted is a proper system of publicity; a canvassing staff, the issue of suitable literature, and, above all, a suitable showroom. It is of no use exhibiting a few motors by themselves; these convey nothing to the mind of the consumer. What is required is a permanent exhibition of motor applications, such as the running of a sewing machine, printing press, sausage machine, &c. We are sure that the makers of such machinery would only be too glad of the advertisement, and would lend it, probably free of charge; the machinery need only be small, but should be connected up with the necessary starters, &c., in order to show it running whenever desired. Station engineers may, perhaps, smile at this suggestion, but a little consideration should show them that when they start a commercial department it must be run on commercial lines, and quite separately from the purely engineering side of the concern.

Mr. Britton points out what many seem to forget—namely, that a day load is not merely an advantage to the supply undertaking. It operates in a cycle, because the greater the output the cheaper the tariff; this encourages fresh consumers, which in turn benefits the electrical industry; whilst the consumer who hires a motor is paying a rent which is helping others to obtain a cheaper rate, it must be remembered that not only does he by this means assist to cheapen his own rate, but he has the advantage of specially cheap power, and the use of a motor of guaranteed

make, which in these days of keen competition is a consideration.

The author appends some tables of electric supply undertakings, giving the number of motors on hire or hire-purchase, and by a simple calculation he shows to what an extent the industry would be benefited if each authority in the country advanced only 12 motors of an average of £50 each for one year. The only objection that can be raised to all this is the increase in municipal debt which would accrue, but, if properly managed on a commercial basis, the benefit which the community would derive would tend to modify this objection.

Standardisation An Appeal.

Our readers are already so fully acquainted with the nature and extent of the invaluable work which is engaging the attention of the Engineering Standards Committee, that a further reiteration of its programme is unnecessary. But though pressure upon our space forbids our setting apart several columns for the publication of an official statement which has been sent to us by Mr. Leslie S. Robertson, the enthusiastic and never-tiring secretary, we have great pleasure in bringing the claims of the Committee to the notice of those who are concerned in the progress of electrical manufacturing and engineering. We believe that the importance of the work is fully appreciated already, but there is now an opportunity for personal interest and appreciation to be displayed in a practical manner. The position which has arisen is this: His Majesty's Government, which has already made a magnificent grant for helping the matter forward, has intimated that the amount of its grant in aid for the year 1904-5 must be dependent *upon the amount contributed by the industries of the country*. The whole question of engineering standardisation is, it is true, a national one, but we think the Government has acted wisely in throwing a greater responsibility upon those who are directly engaged in connection with the industries represented. The Government conditions savour somewhat of a sort of bonus system, which calls for a maximum of individual output in order to get a greater grant in aid from the nation. It therefore behoves all who have the best interests of British electrical engineering at heart to send their biggest cheque possible, either to Mr. J. Mansergh, the chairman of the Committee, or its secretary, Mr. Robertson, at 28, Victoria Street, S.W. The more the Committee hath, the more will be given.

Electric Railways.

Several events have occurred during the past few days in the electric railway traction field, to which prominence should be given. The Great Northern and City tube line, having completed its signalling arrangements to the Board of Trade's satisfaction, was able to commence running for public service on Sunday last, so that London has now four tube lines in operation. The next event of the kind will be the completion of the electrification of the Metropolitan and District, and it may or may not be this year. When it is accomplished, the course of London underground traffic will become more interesting than it has been since the Central London commenced running. The North-Eastern Railway has this week commenced running experimental electric trains over eight miles of its lines in the Newcastle district, and when it is noted that this railway has lost 61 per cent. of its passenger traffic in that locality during the past two years through electric tramway competition, it may be taken for granted that the electric section will be set in operation as soon as ever things are ready and approved, so as to try and get back lost business. The Lancashire and Yorkshire, too, is continuing its electrical trial runs between Liverpool and Southport, and is training its drivers ready for the opening, which doubtless will not now be long deferred.

THE CRYSTAL PALACE AUTOMOBILE SHOW, 1904.

The Crystal Palace is a very big building, and during its lifetime has sheltered some exceedingly valuable cargoes, but it is unlikely that many of these have surpassed in value its present contents. Motor-cars, broughams, vans, omnibuses, and launches, motor bicycles and runabouts, lamps, tires and accessories of every description, motors whole and dismembered, petrol, steam and electrically-driven vehicles, go to make up the very comprehensive collection of exhibits at present on view at the Crystal Palace.

In point of size the present show considerably eclipses its predecessors; as an indication of which may be taken the fact that 130,000 sq. ft. of area are occupied by the 270 exhibitors, as against 87,000 sq. ft. of area in last year's show.

Visitors to the show cannot fail to be struck by the fact that it is distinctly a "Petrol" show, steam and electricity being more than ever in the background for car propulsion purposes.

The Englishman who takes a pride in home-manufactured articles, will, if he has visited previous shows, find consolation this year in the number of prominent British engineering firms, apart from purely motor-car firms, who participate. Prominent among them we noted, Sir W. Armstrong, Whitworth & Co., Messrs. Crossley Bros., who have practically made their *début* as motor-car manufacturers at this show; Messrs. Greenwood & Batley, Ltd., the Hozier Engineering Co., Messrs. Thornycroft, Brush Electrical Engineering Co., Messrs. Milnes & Daimler, Ltd., Messrs. Ransome, Sims & Jefferies, Ltd., and Messrs. Thomas Green & Sons, both of whom provide novelties in the shape of motor-driven lawn mowers; Messrs. Willans and Robinson, who build all the engine and machine parts of the Duryea Co.'s cars.

Altogether some 1,000 cars are on view in the Palace, many of them on stands possessing artistic merit of no mean order, but, unfortunately, obscured by their confined situation. Some 80 cars and cycles were also running in the grounds.

Personally, we should be sorry to judge the popularity of the electrical vehicle from the number of such exhibits, for they are not only few, but very far between, and the latter condition is so inconvenient to those whose interest lies in this type, that we would like to suggest that a considerable improvement might be effected in future shows if an electrical section were established, in which not only electrical cars, but also accessories and small lighting sets could be included. This would prove far more effective, from the spectators' point of view, than isolated exhibits.

Despite, however, the disappointing nature of the electrical car exhibits, the fact that electrical ignition and accessories are more than ever in evidence on the petrol motor-cars, points to at least one satisfactory feature in present and future developments.

Turning to the exhibits of electrical vehicles, that of the Electromobile Co. claims first attention. These carriages admittedly combine all that the expert coach-builder can turn out in the way of luxury and elegance, combined with an electrically equipped chassis car built by Messrs. Greenwood & Batley, Leeds. The straight chassis and under-slung interchangeable battery, peculiar to the Electromobile Co.'s vehicles, is now well known, and was described in our report on the last Crystal Palace Show.

The company's special exhibit this year is a grand C spring electric Victoria, listed at £800. It is fitted with an 8 to 16-H.P. motor with battery capacity for a distance of 40 to 50 miles. Owing to its peculiar construction, the body being swung on springs above the chassis, it is exceptionally easy to ride in. The company also exhibit broughams, landaulets, &c., quality being a self-evident feature, the company only selling the best that money can buy.

The exhibit of the Anglo-American Motor Car Co., Ltd., who make a speciality of Baker motor vehicles, contains among many interesting features, samples of electrical runabouts, Imperials, Stanhopes, Victorias, broughams, delivery vans, trucks, &c., ranging in price from 195 guineas to 750 guineas. The Baker electrical vehicles were described in detail in connection with our report on the previous show.

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The London Electro-Mobile Syndicate have now on view three electrical vehicles, comprising a brougham, a Stanhope, and a doctor's runabout, fitted with brougham top; the prices ranging from £350 to £250.

The Anti-Vibrator, Ltd., of Croydon, also exhibit one of their latest type of electrical carriages, fitted with the patent Certus frame, which is claimed to prevent vibration from being transmitted, and indirectly to considerably lengthen the life of the battery. These carriages are fitted with two driving motors and four brakes. The speed control provides for three speeds forward, one reverse, and one off position. This controller is claimed to be of novel design, and is provisionally patented.

With this brief description of the vehicles, we pass on to the electrical accessories, in connection with which Messrs. Peto & Radford, Ltd., make a comprehensive show, comprising accumulators, volt and ammeters for cell testing, terminals, sparking plugs and ignition devices generally. We were shown what is claimed to be a novelty, in their semi-solid electrolyte accumulator, which appears to be a cross between a primary and a secondary cell. Internally its consists of two positive plates and between them a negative plate in the form of a lead envelope; the so-called semi-solid electrolyte, we understand, consists of lead sulphate in suspension in an acid solution. The cell is charged as an ordinary accumulator, and it is stated that the voltage drops to zero after an hour's discharge. When energy is required, a cadmium pellet is dropped into the negative envelope in each cell, and a pressure of four volts can then be obtained, which ceases on the removal of the cadmium. It is claimed that, as a spare accumulator, this will never run down. We were also shown a patented terminal protector, for accumulator terminals, this consisting of a vulcanite cap into which the usual terminal top is embedded. The insulated wire passes through the top of the cap and is soldered on to the metal terminal inside.

Messrs. Longstreths, Ltd., exhibit, among a profusion of their Lithanode cells, one which is claimed to be absolutely unspillable; this quality being obtained by the addition of a small compartment to the cell, into which the electrolyte spills, and which is provided with a vent for any gas which may collect. It is claimed that corrosion at the terminals is effectively overcome by the Lithanode patent terminal insulator.

Among others exhibiting this class of goods were the Electric Battery Co., of High Holborn, and the N.S. Electric Storage Co., who show samples of their solid type cells.

Turning to magneto-ignition devices, the exhibit of the Simms Manufacturing Co. supplies all that one may want in this direction. Magnetos of the oscillating sleeve type, rotary armature and rotary sleeve types for petrol motors having from one to four cylinders, and for oil or gas engines, are here to be found. The company also exhibit many petrol motors, samples of the "Arbel" pressed steel frames, and several types of car.

In view of the increasing popularity of petrol engine and dynamo combinations for lighting private residences, yachts, &c., the exhibits of such plants by Messrs. Rose Bros., of Gainsborough; Messrs. J. Taylor & Sons, York Road; the Albion Motor Car Co.; the Begbie Manufacturing Co., Ltd.; and the Simms Manufacturing Co., are of considerable interest.

In connection with the petrol motor-car exhibits it was noticeable that with but few exceptions a uniform disposition of the mechanism has been arrived at.

Among those who show any marked divergence, may be mentioned the Arrol-Johnston motor-cars, in which a two-cylinder engine of the balanced type is employed, each cylinder being provided with two pistons which are forced apart by the explosion of the gases between them. These pistons are connected by means of double-ended levers and connecting rods to the crankshaft placed immediately below the cylinders. We noted that the engine was provided with a rotary armature magneto for ignition purposes, and with forced lubrication. The car was fitted with many other improvements, not always found on these vehicles.

The cars of the Lanchester Engine Co., Birmingham, and of Messrs. Wilson & Pilcher, Ltd., Westminster, have engines of the double-ended type, *i.e.*, with the cylinders arranged on opposite sides of the crankshaft.

A feature which was noticeable in connection with the Petrol Car exhibits as a whole, was the attention which is now being bestowed on the small "Runabout" type, ranging in price from £80 to £120.

On the whole it is probable that the Miesse Steam Car combined more interesting features than any other exhibit. In this car, steam is generated in a flash boiler, paraffin fired, the working pressure being from 300 to 1,200 lbs. per sq. in., according to the amount of power required.

The steam is utilised in a little horizontal single-acting three-cylinder engine, having mushroom type valves, the inlet being above and the exhaust below the cylinders.

No change speed gear is fitted, speed regulation being obtained by varying the water supply to the flash boiler, and consequently the steam pressure. It is claimed that this car uses cheap paraffin, and at the same time can operate over much greater distances, and owing to its flexibility in power, over more awkward roads than a petrol vehicle.

This year has also witnessed an influx of heavy vehicles and launches. Of the former the petrol-paraffin motor 'busses, and lorries of Milnes-Daimler make, the Thorneycroft, Straker and Coulthard steam wagons, the Caravan Restaurant Co.'s exhibit, and the minature traction engines of Messrs. Wallis & Steevens, Ltd., and Messrs. Tasker and Sons, are noteworthy examples. In the launch section are to be found both steam and petrol-driven launches—the principal exhibitors being Messrs. Simpson, Strickland and Co., of Dartmouth; Messrs. J. I. Thorneycroft & Co., Chiswick, and J. E. Hutton, Ltd.

Although open to the public some days previously, the exhibition was not officially opened till Saturday last, when an inaugural luncheon was held, presided over by the Hon. J. Scott Montague, M.P., vice-president of the Automobile Club of Great Britain and Ireland. Speeches were delivered by Lord Stanley, Postmaster-General; Mr. F. R. Simms, Sir John Macdonald, Colonel Saunderson, and others.

The Exhibition remains open until February 24th.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Electricity in Mines and Electric Coal Cutters.

I am pleased to be able to record that we can run our coal cutters with satisfaction. Our machines have the disc-cutting wheel for Longwall cutting, and are at present cutting in very hard stone. In some cases the cutting wheel is apt to climb up the face, but that depends upon the position of the machine and the cutters in use, and is no fault of the electric motor; a compressed air machine has just the same troubles to deal with, and I am certain that a 26-H.P. motor is every bit as good for coal cutting as a 26-H.P. compressed air machine, and we cannot blame the electric motor because the wheel rises in the face and goes to port or starboard, as the letter of Mr. L. E. Wood suggests in your last issue. So long as the electric motor runs with satisfaction and gives the horse-power it is made for, and drives the machine, it depends on the management of the driver and road layer for success in cutting.

It is best to have the cutting wheel working 3 or 4 in. from the floor on account of it being apt to take the cuttings back into the face and choke itself. This can be avoided to a great extent by having a man behind the machine who understands his work, and who is not afraid to use a shovel to help to keep the wheel clear. Now in respect to changing the coal-cutter armatures, a day is quite little enough, because attention should be paid to all other parts of the motor, and to faults if any should have developed.

But, of course, if armatures have to be changed once or twice a week, it is a big item. Now, for myself I should grumble if I had to change my armatures under less than eight or ten months' running. I have my motors protected by suitable fuses, which does not allow them to exceed their safe working limit. When the armature coils keep on burning out 19 times out of 20, it is through overload. Sometimes armatures will go wrong through vibration, but in my case it has been very rare; I also make a practice never to change an armature in the mine. If any of the commu-

tators require turning up, I have the motor box complete hoisted out of the frame of the machine, placed on a trolley, and sent to the surface. The frame of our motor is cast in one piece.

To take out our armatures, we take the panel off the back of the motor box, raise the armature shaft at that end and put a small wooden roller under it. Then we go to the front and take hold of the shaft and lift, at the same time gently drawing the armature to the front, where we can take hold of it and lift it straight up. We never slide our armatures along the pole-pieces in doing this, because the wooden roller is made to keep the armature the same distance away from the pole-pieces as the bearing, and it rolls along the motor-box bottom, at the same time keeping it clear of the pole-pieces, and I can say with truth that we have taken armatures out, and put them in without a scratch.

But the main thing to remember is to keep all electrical machinery clean; I have rules printed for our coal cutter drivers to work to. Every morning they have to take the cover off the front of the motor box, which is not a five minutes' job. Then wipe the commutator brushes, brush springs, &c., and every week end blow all dust out of the armatures with a pair of bellows, and wipe all clean.

I do not believe in allowing my motors to run like some I have seen with a great deal of copper and coal dust, oil, &c., inside the motor box. Nobody can expect an electrical coal cutter to work satisfactorily under those conditions. Another point to observe is to allow the machine to start on as light a load as possible. Our drivers, before stopping their machine, lift the catch up, and prevent it from pulling along the face and into the cut, so that when they start the machine again it is not right into the cut which, means a much lighter load. I may say that we do not cut in soft coal, but very hard stone, and we are not doing badly.

I am rather surprised at the letter of Mr. L. E. Wood in your last issue in reference to the Diamond coal cutter, because I do not think there are many more firms who have made such extensive experiments in this branch of the trade, and with more satisfaction than the makers of the Diamond coal-cutter, although our machines are not of that make. I also think we have not much to fear from compressed air, because electricity is a cheap motive power compared to some. For one thing, the cables do not require the fixing that compressed air pipes do, and everything requires less space, which is a great item in mining work. Of course, I know that compressed air increases the ventilation, but still it will not provide light to work by, and the same cables do both for power and light, and take less room in a shaft than pipes, and are not so heavy. I do not think we have much to fear in that direction, because owners and managers are becoming aware of the advantage and cheapness obtained by employing electricity.

In our colliery we are going to install another coal-cutting machine, and I do not fear its arrival, because it will mean a greater output of coal and more work for hands, and a cheapened output (so I say, let 'em all come). We also have some of the machinery here for installing electric winding in place of steam, and I am pleased to say, it is both large and powerful; so our firm must see their way clear in this undertaking to save money. Hoping that you will excuse this long letter.

John Bentham,
Electrical Engineer.

New Sharlston Collieries,
Near Normanton.
February 13th, 1904.

As a regular reader of your excellent paper, and being an electrical engineer to a colliery company in the Midlands, I was interested to read your correspondent's letter on "Electricity in Mines" in your issue of January 29th. Having an extensive electrical plant, including six Longwall disc machines, also a "Jeffrey" heading machine, I should like to say a little on the use of these machines in mining operations.

Referring to your correspondent's letter, I am at a loss to understand why the "Jeffrey" machine should be on the scrap heap. I have had one of these machines at work for the past two years, and perhaps it would not be out of place to give some details as to the performance of the machine.

For 12 months this machine has been at work in a coal heading in a hard coal seam. The heading was 30 ft. wide, the seam being 5 ft. 6 in., with a dip of 1 in 9 ft. The coal was much too hard for hand-holing, and the roof bad.

The machine holes 6 ft. under and 3 ft. 6 in. on. The average time taken to cut across the heading, including setting the machine, shifting and resetting timber, &c., was 4½ hours with two men at the machine, representing 180 sq. ft. of coal holed. The average time taken by one man to hole a stint in the same place 4 ft. on and 3 ft. under was eight hours; so that the above results show what can be done with the machine when properly used.

During the whole time I had no trouble with the machine except a starting switch broken by a fall, neither did I experience any trouble through the machine lifting, as mentioned by your correspondent, and I am inclined to think it would not occur if the machine was properly used.

With respect to the disc machines, I experienced the difficulty with the machine "climbing" up the face. After several experiments, I found this was due to the machine not being level, and also to the shape of the cutters in the wheel. I then had a special set of cutters made, and although the machines are at work almost night and day, I have not had the least trouble in this respect for over 12 months.

The machines I have, are at work in various seams, and each has 6-ft. wheels, holing 5 ft. 6 in. under, and I do not see why the wheels cannot be prevented from climbing in any seam where the conditions are at all favourable for machine holing.

With regard to removing the armatures and pinions, I should say that the cost of repairs to a number of machines for 12 months would make no small item if carried out by your correspondent.

The armatures, &c., belonging to the machines I have are much heavier and more difficult to remove than those belonging to the Diamond machines, which I consider are among the best for repairs, and to remove an armature, replace two field coils, and put the machine together again takes from three to four hours at the outside, and I have had an armature alone brought from the surface, the old one taken out and replaced, and the machine got to work again in less than 1½ hours. I do not find it necessary to waste any time in removing pinions; I simply keep a pinion on each armature, and consequently save the time of taking off and fitting on, &c.

In removing the armatures, which with some, results in more damage being done to the armature than the cause of it being removed, I lay a thin sheet of vulcanite along the bottom of the pole-pieces and have plenty of bags ready to rest it on as soon as it is clear of the frames, and in this way it is possible to remove the armatures without the slightest damage, and if your correspondent would get a piece of pipe large enough to fit on the end of the armature shaft of sufficient length for two men to hold, he will find the armatures can be lifted out clear of the frames without any trouble.

The trouble which your correspondent experiences with the connections between the field coils can easily be overcome with a little brains properly applied, by bringing the ends of the coils to the commutator end of the motor, the cross connections passing under the commutator where there is plenty of room.

To do this I have fitted some suitable terminals mounted on slate bases inside the bottom half of the case enclosing the commutator, and by this means the whole of the connections are easily accessible on removing the cover over the commutator.

There is, no doubt, a splendid field for electricity in mining operations, and I consider, from practical experience, that it is the ideal power; but, at the same time, the men in the field must not let the grass grow under their feet. Some of the machines, no doubt, could be improved, but I do not see that split cases for the motors would be any improvement. My experience is, that there is most room for improvement in the switch-gear in electric coal-cutting machines.

In conclusion, I hope the remarks I have made will be of some little assistance to your correspondent, who, with a

little more experience, will be able to overcome at least some of the existing troubles with electricity in mines.

W. Smith, *Engineer.*

Sutton Colliery, Sutton-in-Ashfield,
February 15th, 1904.

Hydraulic Tests for Lead-Covered Cables.

Our attention has been called to the paragraph in your issue of 22nd ult., relating to our patent hydraulic tests for lead-covered cables. In your paragraph you state that Messrs. Siemens apply the hydraulic test to their submarine gutta-percha cable, and you have juxtaposed the statement in such a way as to lead to the inference that there is no novelty in our process. Practical experiments, however, have indicated to us that there is a great difference between the testing of gutta-percha cables and lead-covered cables. It has been conclusively proved by us that quite a moderate pressure—say, 100 lbs. per sq. in.—will detect incipient flaws in the lead covering which are not detected by the ordinary tank methods of testing; whilst it is also well known that such pressures are, in the case of gutta-percha-covered cables, of little or no use.

It is quite possible that this arises from the fact that in the case of gutta-percha-covered cables the covering is in itself a semi-fluid or plastic covering only capable of very slight compression, and any pressure applied therefore tends to close faults, and the only real use of such a test is to discover the presence of air bubbles in the covering, to do which the pressure required must be equal to the deep-sea pressure to which they will be eventually submitted.

In the case of lead-covered cables, compared to the pressure applied, the lead covering is a rigid envelope, inside of which there is a certain amount of spare space, and a pressure of, say, 100 lbs. per sq. in. is quite capable of forcing water through incipient faults in the lead envelope, and thus enabling such to be detected.

The fact that no other manufacturers have carried out experiments, or realised what an important step in lead-covered cable testing is thus achieved, is, we think, one of the strongest arguments in favour of its novelty.

W. T. Glover & Co., Ltd.

Trafford Park, *February 15th*, 1904.

Dudley Tramways.

I notice the paragraph from your local correspondent on the series of mishaps lately recorded by the police, and am surprised to find no mention of what will one day be a serious matter for the company running these cars. If your correspondent will make one or two trips on a real wet day (and now's the time) on any of the cars running from Dudley to Brierley Hill, he will probably discover that it is not wise to touch metal work in any part of the car, unless, of course, being, as I take it he is, an electrical man, he is not easily shocked.

I never get on to one of these cars now unless I have a pair of rubber shoes with me, and two tobacco pouches, as I have on more than one occasion received severe shocks. The last time this happened (about three weeks ago) I was passing the trolley pole, and was misguided enough to place the palm of my hand on the iron upright, one foot at the same time touching the baseplate, and I received a shock which left me without feeling in my forearm and fingers for nearly an hour. A friend who was with me at the time, happened at the same moment to put his hand on the top rail at the side of the car, and he also found things lively. Two years ago I got hold of the brass upright on the step of a car outside the station hotel at Dudley just as a car was starting, and the shock I received then threw me clean off my feet. I am sure you will agree this is not a satisfactory state of affairs even for people in good health, and goodness knows what it might mean to an invalid or to a woman in an interesting condition.

There is a very curious notice posted inside these cars as to the company's liability for damages, and, perhaps, your correspondent can send you a copy of it so that your readers may become aware of the conditions under which they are carried on these electrificable vehicles.

Whilst on the subject, I should like to mention another peculiarity; as far as I know all their own. They are heated by the motors so that the seats immediately over the motors are sometimes so hot that you cannot sit on them. Perhaps this is the latest thing in car heating; but I don't think it can be claimed as an American invention, although I know they are great on these small comforts.

F. A. Yerbury.

Faraday House Appointments.

If I may join in the discussion from the point of view of the assistant in a station, on whom much of the training of the third year student of necessity devolves, may I criticise in good part the theoretical training given by Faraday House?

It does not appear to me to be satisfactory to take a student from an ordinary good school, even granted that he has a taste for scientific work, and endeavour to teach him the science of electrical engineering in 12 months. Faraday House pupils come into a station with a half-assimilated mass of text-book theory and some little knowledge of fitting shops. Their business knowledge is *nil*. We do our best for them, but are unable from stress of work to do much to teach them how to use and adapt their theory for working conditions.

I think that it is a great pity that Faraday House does not do more for its second and third year students than it appears to do. If it is not possible to devote a longer time to training in the schools, then at least a system of correspondence classes could be devised so as to keep the student up to his work, and show him how to use that theory which he obtained in his first year to the greatest possible advantage.

If this or something equivalent could be done, it would certainly help and encourage the students, and give some definite lines along which they could extend their technical knowledge to their present and future profit.

H. L. M.

February 15th, 1904.

With regard to the controversy concerning Faraday House appointments, which has appeared in the columns of the Electrical Review, may I, as an unfortunate individual who has not been favoured with the Faraday House course, but one of those fortunates whose training has not consisted of "being dragged through a two years' course at a provincial central station," tender a few remarks.

I have come in contact with Faradians both in the central station and the manufacturing business, but never before have I heard one of their number utter such statements as those made by "Old Faradian." I always look upon Faradians as a brotherhood, very much akin to Freemasons, and should a vacancy occur under an old Faradian, woe betide a non-Faradian (no matter if he is the better man) who applies for the position if one of "the band" is amongst the applicants.

As "R. W. R." remarks, "Old Faradian" appears to think that Faradians should *always* be given the preference; but he must bear in mind that there are *just* as proficient engineers who have not passed through the portals of Faraday House.

The theoretical man is indispensable, but it is the thorough practical man, after all, who has to convert that theory into actual practice, and there is no doubt that an engineer with a good practical experience is by far the most capable man to hold the position as chief of a central station.

"J. T. T." seems to have gone rather away from the point when he mentions manufacturing firms, as "Old Faradian" more particularly emphasises central stations; and, from my own experience, the salaries paid in stations are decidedly lower than those paid in the manufacturing business.

R. S.

[This correspondence is now closed.—Eds. E.R.]

Explosion of Enclosed Arc Lamps.

Referring to your correspondence under the above heading in the last number of the Electrical Review, it may be of interest to know that for several years past all enclosed arc lamps supplied by the British Thomson-Houston Co.,

Ltd., have been fitted with devices, making it absolutely impossible for any trouble to result from sudden expansion of gas in the enclosing globe. We may say that in all our experience with enclosed arc lamps, we have never known of a case in which the enclosing globe of any of our lamps (either the drop frame type or fixed frame type) exploded.

The British Thomson-Houston Co., Ltd.,
C. L. O.

Rugby, *February 9th*, 1904.

The Collection of Technical Matter for Reference.

Many of your readers have doubtlessly collected, at one time or another, information relating to some plant or work on which they happened to be engaged, with a view to keeping it for future reference. Such information generally possesses a peculiar value of its own, and helps to clear up difficulties that may arise at some future time. In fact, without some reference of this kind, it is hardly fair to expect that full advantage can be taken of past experience, which should guide the policy to be adopted in the future. However, the building up of such a collection of information presents many difficulties. Such publications as *Science Abstracts*, and the journals of the proceedings of the technical institutes (minus some of the elongated discussions) are very useful, but, obviously each individual requires, in addition to them, such a reference that meets the peculiar wants of his own case. In this direction some of your readers must have been to a great extent successful; by placing their experience at the disposal of others they would serve a very useful purpose.

J. T. M.

Radium: A Guess.

Here is a bit of speculation in regard to radium, and those of its kidney, and other atoms:—

Is it possible to conceive of its acting as or in some way like a *lens*, concentrating and focussing within and about itself some unknown rays, or otherwise uninterrupted, or only partly interrupted, rays, and so setting up within and about itself, as an atom, a little *inferno?*

J. C. R.

The Bristol Fire.

In reading the correspondence *re* the Bristol fire in the Review, during the last few weeks, the one thing that strikes anyone accustomed to alternating-current work, is the failure of several of your correspondents to grasp the details of the subject under discussion. As an instance, one correspondent suggests that automatic stop gears should be fitted to every engine, his idea evidently being that by this means the plant could have been shut down so rapidly as to prevent, or, at least, minimise the damage done. This idea would have been perfectly correct for all direct-current work, but is practically useless when applied to alternating-current stations, more especially to a station fitted up as Bristol was, where not only were their several alternators running in parallel, but also in parallel with the plant at the Avonbank station. Therefore, immediately your correspondent "pressed the button," all he would do would be to cause the generator to become a motor, and, probably, get out of phase with the rest of the plant, and thus short-circuit all the current delivered to the bus-bars through the armature of the generator which he had attempted to shut down.

It sounds so easy to say, "Press the button, and shut her down," but in a case like this it would have been, "Press the button, and burn up the generator," and instead of the fire being confined to a few panels of the switchboard, practically the whole of the station would have been burnt out, because once he had pressed the button, and the machine had got out of phase, he would have found it nearly impossible to get the switch out again, and had he shut the whole of his plant down there was still the current coming from the Avonbank Station to be reckoned with, and these would have been practically running on a short through the armatures of the generators, which they had attempted to shut down by means of pressing the button. I should not have troubled to write this letter, pointing out what would most probably occur in the above circumstances, only that the correspondence upon this subject is being most eagerly read by juniors anxious to know how to act in cases of emergency, and the letter on emergency stop-gear was likely to give them a wrong impression.

G. Trenbath.

Bramley, near Leeds.

Electric Rock Drills.

In your last issue I notice a letter from Mr. Gibson with reference to electrical drills. Being interested in a slate quarry where 3-phase current is about to be installed, I should like to hear this gentleman's views on the subject, with a view to a drill being tested.

Idris.

THE FIRE AT THE CHICAGO THEATRE.

The Iroquois Theatre fire has been reported upon by Mr. F. J. T. Stewart, of the Chicago Underwriters' Association, and it appears in full in the January issue of *Insurance Engineering*, which has just come to hand. Although the real origin of the fire was electrical, the unfinished condition of the building, together with the highly combustible scenery of the spectacle, are shown to have combined a remarkable number of unfortunate circumstances, most of which contributed liberally to augment the disaster. These circumstances Mr. Stewart summarises as follows, and we commend them to the careful study of all who are concerned in the protection of public buildings, however fireproof they may be as mere structures. Nos. 1, 2, 4, 10 and 11 are of direct interest; but we print the whole of the points because the great attention that the matter has attracted renders it desirable that the entire story of negligence and error, authoritatively told, should be placed on record:—

1. Eight electric arc lamps on stage used for "flood" and "spot" lights and not entirely enclosed. It is also claimed that the metal casings of these lights could be sufficiently heated in operating to ignite combustible material if in contact with them.
2. Practically no fire protection on stage or elsewhere on premises.
3. It is claimed that considerable time was wasted trying to extinguish the incipient fire on hanging curtain by the use of dry powder chemical extinguishers (so called). The only fire apparatus on the stage consisted of six tubes of this dry powder.
4. No fire-alarm apparatus on premises.
5. It is estimated that the fire had been burning fully ten minutes before any alarm reached the city fire department.
6. The asbestos curtain was inoperative; probable cause was obstruction by the proscenium light board hinged on wall and said to have been swung out under north end of curtain at time of fire. Curtain temporarily mounted on wooden sheaves.
7. Proper controllers for ventilators unfinished, and the ventilators chanced to be in the most unfavourable condition at time of fire, vents over stage being closed, those over auditorium open, and exterior door from stage floor immediately opened.
8. Exits were not suitably marked. Door at front end of top promenade leading to stairway was locked. Attendants were not properly drilled, and apparently only two of the ten alley exits at north were opened. Each of these exits had glass-panel doors and a pair of swinging iron shutters latched shut. The gallery did not have a main entrance and exit of its own.
9. It is estimated that approximately 200 persons were standing in aisles and passageways, principally in the gallery.
10. There was no automatic sprinkler system protecting the stage and other hazardous portions.
11. The electric lights for the auditorium were not under proper control for such emergencies, being dependent on the stage control for their operation. There was no special illumination of the exits by red lights or other indicators.
12. Opening through proscenium wall from orchestra pit was not protected by a fire door.
13. No employés of city fire department on premises.
14. Wired glass used in ventilating skylight over stage, in place of thin glass with wire screen above.
15. All ushers and other employés in auditorium deserted their posts at time of fire; in fact, they had no instructions as to what they should do at such a time.
16. The superior character of the building construction apparently created over-confidence, which caused the absolute necessity for proper fire protection and ordinary precautions to be overlooked. The inflammable contents of the fireproof building, without proper sub-division, are scarcely any safer as regards destruction by fire than if they were contained in a building of ordinary construction.

Electrical Imports in the Transvaal.—The value of the electrical cables, wires, and fittings imported into the Transvaal during the ten months ending with October last, is returned at £58,000, as compared with only £36,000 in the first ten months of 1902.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"Foucault" writes:—(1) "In proceeding for a provisional order, 'on or before December 21st the promoters must lodge a memorial with the Board of Trade.' What is the effect if this be not done to the time stated? Does it render void previous proceedings with regard to the order, such as advertising, &c., so that these proceedings must be undertaken anew?

(2) "'Objectors to an application for a provisional order must bring their objections before the Board of Trade on or before January 15th next ensuing.' What would be the result of objectors omitting this?

(3) "Is there any place at which one may inspect copies of advertisement of the intention of a company, or person, to apply for a provisional order."

*** With regard to (1), so far as can be gathered from the Electric Lighting Acts, and rules made thereunder, any applicant for a provisional order must implicitly carry out the rules and regulations which are made by the Board of Trade. The Electric Lighting Act of 1882 provides (in effect) that the Board of Trade may from time to time by provisional order authorise . . . . any company or person to supply electricity, subject to certain provisions. One of these requires that no provisional order shall authorise the supply of electricity by any person, unless notice of the application is published by advertisement in such manner, and including such particulars, as the Board of Trade may from time to time direct or approve. It is further provided that a provisional order shall not be granted by the Board until after the expiration of a period of three months from the date of the first publication of such advertisement, nor until opportunity has been given to all parties interested to make representations or objections to the Board of Trade with reference to the application.

If, in accordance with the power so conferred, the Board of Trade think it right to fix any particular day, it would seem that that day must be regarded as fixed by statute, and that in default of notice being given the subsequent issue of advertisements, &c., is of no use. At any rate, there is nothing in the rules made by the Board of Trade under the Electric Lighting Acts, 1882 to 1890, which provides for the contingency of an omission to give notice on the proper day.

With regard to (2), it appears from Rule 14 of the Board of Trade rules that objections must be lodged before January 15th. There is nothing in the rules which provides for any exception to this provision.

With regard to (3), Rule 13 of the Board of Trade rules provides as follows:—Applicants for a licence or provisional order must proceed as follows, subject in the case of a licence to the application having been entertained by the Board of Trade: They must publish notice by advertisement of their application, or in the case of a provisional order, of their intended application, and every such advertisement must contain the following particulars:—

1. The objects of the application.
2. The address and description of the applicant.
3. A description of the proposed area of supply. . . . .
6. The address of an office in London, and another office within the proposed area of supply, at which printed copies of the draft licence or order when applied for, and of the licence or order when made, can be obtained at a price of not more than 1s. each.

This seems to answer the question put by "Foucault." It might be added that a copy of the Board of Trade rules can be obtained from Messrs. Eyre & Spottiswoode for a few pence.

THE WELDING OF ALUMINIUM.

At the meeting of the Faraday Society on Tuesday, February 2nd, Mr. Jonas read an abstract of a paper by Mr. S. O. Cowper-Coles, entitled "Notes on the Welding of Aluminium." The author commenced his paper by stating that soldered aluminium joints have proved unsatisfactory, as they will not stand the test of time, because galvanic action takes place between the aluminium and solder. One of the chief difficulties encountered in soldering aluminium other than the formation of oxide, is that a few degrees below its welding point it passes into a pasty or brittle state, and, being a very good conductor of heat, the solder very rapidly cools and freezes before it has time to flow sufficiently. He then proceeded to describe Dick's machine for welding aluminium by the removal of the oxide mechanically, combined with pressure. Reference was also made to Heraeus's process of welding aluminium, which consists in heating the aluminium in a reducing atmosphere until it reaches the pasty stage, when the joint is made by kneading and hammering. Emmé's process, which is somewhat similar, consists in heating the aluminium up to 600° C., and welding by hammering. The electric welding of aluminium has not proved commercially successful. A description was given of Schmidt's electric welding apparatus, which consists of a carbon stick, which is used in much the same way as a soldering iron, by being moved over the portion to be welded to remove the oxide, the aluminium forming one electrode, the carbon stick the other electrode. Jones's machine for welding aluminium tubes was also illustrated; a strip of aluminium is wrapped round a mandrel, and the joints are fixed together by passing a low tension current through the portions to be welded. The author then went on to describe his own process, which requires no flux or solder, and does not necessitate the hammering of the joint when in the pasty state, the process being especially suitable for wire, rods, and tubes. The machine employed is fitted with clamping screws which are controlled by levers. The aluminium is heated by a benzine lamp, and when raised to the point of fusion, pressure is applied to the levers, which causes the aluminium to be welded, to unite, a ring of metal being squeezed out. This ring, which is largely composed of oxide, acts as an insulating and supporting collar, the molten metal being retained within it. Water is then projected on to the joint by turning a handle, at the same time a screen is moved in front of the flame. The rod is then removed, and when the collar is filed off the joint will be found to be as strong as the rest of the metal. A table was given showing the tensile strength of 12 consecutive welds; in all the tests the specimen broke at some distance from the weld, and in no case did it actually break through the weld. Illustrations were given demonstrating how molten aluminium can be encased in a shell of aluminium oxide.

In the course of the discussion, Mr. Blount said when drawn wires were welded, it was essential that the joint be drawn or worked in some way, otherwise, being cast metal, it would be weaker than the rest of the wire.

Mr. E. Kilburn Scott said that the important point to remember was the value of the hard outer skin of the metal. If aluminium wires were used for transmission of electricity, uniformity of section was unimportant, and the blob at the weld need not be removed. But otherwise, *e g*, if used as trolley wires, it would be necessary to harden the joint in some way; this might be done by burnishing with agate.

The President (Dr. J. W. Swan, F.R.S.) said that the apparatus showed a thorough appreciation of the conditions necessary to effect a weld, and in dealing with the film of oxide so as to hold together the molten metal, it made a virtue of a vice.

Mr. Jonas, in his reply, drew attention to the tests of tensile strengths of jointed rods given in the paper. In reply to Mr. Blount, the joints proved to be the strongest part of the rods. The quenching was an essential feature of the process, and one which distinguished it from all others, the process being primarily a fusion process.

LEGAL.

Mayor and Corporation of Swansea *v.* The Swansea Improvement and Tramway Co.

In the Chancery Division of the High Court of Justice on 9th inst., Mr. Justice Buckley had before him this case, by which the plaintiffs claimed a declaration that upon the true construction of the Tramway Act, 1870, and the Swansea Tramway Act of 1882, the plaintiffs were entitled, if by special resolution passed in accordance with the provisions of the 43rd section of the Tramways Act, 1870, they decide within six months from February 28th, 1906, that being the date of the expiration of 21 years from the completion of such tramways authorised by the Act of 1882 as had, in fact, been constructed, and within six months after the expiration of every subsequent period of seven years, the approval of the Board of Trade having been obtained, to require the defendant company to sell, and the defendant company were thereupon bound to sell to the plaintiffs the whole of the tramway undertaking within the borough of Swansea. They also asked for a declaration that, upon such purchase being made, the defendant company were not entitled to have any lease granted to them by the plaintiffs of the purchased property, or any part thereof. Plaintiffs' contention was that by virtue of the Tramways Act of 1870, they were entitled upon giving the proper notices to take over the tramways constructed after the expiration of 21 years from their construction. The defence was that the Board of Trade had properly refused to sanction the purchase, as the time was not yet ripe, and the defendants claimed the right to oppose sanction being given by the Board of Trade.

Mr. Warrington, K.C., and Mr. R. J. Parker appeared for plaintiffs, and Mr. Balfour Browne, K.C., Mr. Haldane, K.C., Mr. Buckmaster, K.C., and Mr. P. Wheeler for the defendants.

The matter having been argued at length, his Lordship gave judgment on Wednesday, February 10th.

His Lordship said in this case plaintiffs asked the Court to declare what were the rights, as between plaintiffs and defendants, in an uncertain future—namely, in the event of the plaintiffs availing themselves of a statutory option to purchase defendants' tramways. The defendants concurred in asking the Court to say what those rights were. The question depended upon the construction of a certain Act of Parliament. But for the request on the part of the defendants he should have felt considerable doubt as to whether he could thus prematurely declare what the rights would be in a future event, but it seemed the defendants also wanted to know his view as to the construction of the Act of Parliament, and he had no objection to expressing it, leaving the question open as to whether the declaration he now made would be binding if a future event should hereafter happen as between the parties, who at that time were interested in the question to be determined. The facts were these:—In 1882 the defendants held three statutory rights for making tramways, and had made, in whole or in part, tramways

under those several authorities. They were respectively of date July 16th, 1874, July 4th, 1878, and August 11th, 1879. In each case Part 3 of the Tramways Act, 1879, in which Section 43 was included, applied, and the result was that, at certain intervals, the first of which was 21 years from each of those three respective dates, and subsequently at intervals of seven years, the plaintiffs had statutory rights, if they were so minded, to buy those three respective tramways of the defendants. The earliest dates at which those several options would arise were 1895, 1899 and 1900. In that state of facts, in 1882 was passed the Act which he had to construe. The three systems of 1874, 1878 and 1879 were sets of tramways in Swansea, communicating one with the other except that one small portion of the earliest set of tramways was detached. The tramways authorised by the Act of 1882 effected certain connections between the previous existing tramways—a sort of semi-circular route forming connections between some parts of the previous system. The Act of 1882 contained Sec. 35 upon which the question to be determined arose. The Act incorporated parts two and three of the Tramways Act, 1870, and thus included Sec. 43 of the Act of 1870, and by Sec. 3 it defined the tramways as meaning the tramways of 1882. He therefore had to read the Act of 1882 as if it contained Section 43 of the Act of 1870, and contained also Section 35 of the Act of 1882. Section 35 created in the plaintiffs a new right of purchase altogether in the tramways. The plaintiffs sought to say that a new statutory option to purchase all four sets of tramways as forming one amalgamated undertaking had become vested in them. He was unable to arrive at any such conclusion. He did not think the section had any such effect. Section 35 of 1882 was not affirmative but negative. It proceeded on the footing that there being already by virtue of Section 43 of the Act of 1870 a right to purchase at various dates to be ascertained in the way he had mentioned, the Corporation should not purchase except in the way mentioned in Section 35. It was wholly negative and in no way affirmative. It was addressed to two sets of facts—the first where the lease of the tramways or some part of them had been granted by the Corporation to the company, in which case during the existence of the lease, the Corporation were not to buy the company out unless the company agreed; and in the second case where no lease had been granted, they were not to buy until the expiration of the 21 years from the completion of the tramways. Originally the time was 21 years, not from completion, but from authorisation. As a matter of fact, the tramways were completed in 1885. The effect of Section 35 was that until 1906 the Corporation were not to exercise the statutory power to purchase, conferred by Section 43 of the Act of 1870. There was no new right of purchase at all. It was a prohibition, restriction, or limitation imposed upon the existing right of purchase. The plaintiffs had said that if that was so the result would be very extraordinary; that if a lease were granted it might postpone the right of purchase for several periods of 21 years. So far as his Lordship saw, that was so. He did not see anything irrational in that state of things which would lead him to come to a contrary conclusion. The object might have been to keep the whole undertaking in the hands of either the company or the Corporation. He agreed that that would have the effect of preventing the Corporation from becoming masters of the situation for a much longer time, but that was perfectly sensible and perfectly intelligible. He thought, therefore, he ought to declare on the first point that upon the true construction of Section 35 of the Act of 1882 the effect was not to create any new right in the plaintiffs to purchase the tramways or any of them, but only to restrict or limit the right of purchase existing by virtue of Section 43 of the Act of 1870. On the second, or subsidiary point, he must declare according to the true construction of Section 34 of the Act of 1882, the purchase there mentioned was not as regarded the tramways of 1882, confined to a purchase, under Section 32 of the Act of 1882, but included purchase under Section 43 of the Act of 1870.

He accordingly made those two declarations.

ELECTRIC TRAMWAYS CONSTRUCTION AND MAINTENANCE CO.

THIS matter came before Mr. Justice Byrne in the Companies' Winding-up Court on Tuesday on the petition of F. H. Barr and others.

Mr. WHINNEY, for the petitioners, said the petition had stood over on a previous occasion to allow of amendment. This had been done, and the company had now approached his clients with a view to the petition again standing over. They had offered petitioners a certain sum of money, which it was possible they might be able to accept.

His LORDSHIP directed the petition to stand over for a week.

M'CULLAGH *v.* THE PRESIDENT AND PROFESSORS OF QUEEN'S COLLEGE, GALWAY, AND OTHERS.

A CASE has lately been occupying the attention of Mr. Justice Gibson and a special jury at Duolin, in which plaintiff (an infant) sued through his father to recover damages for personal injuries alleged to have been caused to him by the alleged negligence of defendants in the use of Röntgen ray apparatus.

LLOYD'S PACKING WAREHOUSES, LTD., *v.* VERITYS, LTD.

AT the Manchester Assizes on 11th and 12th inst., Mr. Justice Jelf heard a great deal of further evidence in this case. The Judge said he was afraid it would have to be an adjournment *sine die*. He would do all he could to get it on again within a reasonable time, but the cause list at Liverpool was certainly not a light one. Mr. Horridge said he would mention it at Liverpool if necessary. The Judge assented. The *Manchester Guardian* understands that, if time cannot be given at Liverpool, the remainder of the evidence and arguments of counsel will be heard in London.

HILL *v.* BRITISH WESTINGHOUSE CO.

AT the Salford County Court on 8th inst., plaintiff, a moulder, took action against defendants, his former employers, claiming damages for injuries. He alleged that while carrying some molten metal by the use of an apparatus called "shanks," the latter broke, and he received serious injuries. After hearing medical and other evidence plaintiff was awarded £75 damages. £25 had been paid into Court.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING FEB. 17TH 1903.		WEEK ENDING FEB. 16TH, 1904.	
Alexandria	Value £45	Adelaide	Value £72
Amsterdam	505	,, Teleg. mat.	1,080
Auckland	762	Alexandria	96
Bombay	141	Amsterdam	70
Buenos Ayres. Teleg. mat.	895	Auckland	329
,, Teleph. mat.	380	Bangkok	28
Calcutta	842	Bombay	181
Cape Town	154	Buenos Ayres	250
Channel Islands	9	Calcutta	600
Durban	1,201	Cape Town	83
,, Teleg. mat.	6,200	,, Teleg. mat.	60
,, Teleg. plant	6,961	Colombo	717
Flushing	170	Durban	677
Gibraltar	10	,, Teleg. mat.	325
,, Teleg. mat.	12	Gibraltar	62
Havre	50	Hamburg	34
Hong Kong	98	,, Teleg. mat.	150
Inhambane	10	Hong Kong	975
La Plata. Teleg. mat.	102	Launceston	64
Lyttelton	56	Leghorn	50
Madras	18	Lyttelton	24
Malta	25	Melbourne	60
Melbourne	105	,, Teleg. wire	535
,, Elec. motors	457	Otago	119
Monte Video	70	Perth	397
Otago	41	Port Elizabeth	109
Perth	450	Rockhampton	36
Port Elizabeth	40	Rosario	406
Port Said	10	Rotterdam	9
Rio de Janeiro. Teleg. mat.	225	,, 57 tons teleg. wire	—
Singapore	59	St. Helena. Teleg. mat.	70
Sydney	822	St. Petersburg. Teleg cable and wire	1,338
Wellington	60	Salonica. Teleg. mat.	64
Yokohama	255	Shanghai	611
		Singapore	12
		,, Elec. cables	3,559
		Sydney	444
		Wellington	527
		Yokohama	225
Total	£21,180	Total	£14,448

Foreign Goods Transhipped.

Durban. Elec. mat.	Value £25	Flushing. Elec. mat.	Value £100
Gothenburg. Elec. appar.	29	Fremantle. Elec. machinery	2,748
		Trinidad. Teleph. mat.	95
Total	£54	Total	£2,943

Vulcan Speed Indicator.—We have received from Messrs. Geipel & Lange, 72A, St. Thomas's Street, S.E., particulars of an ingenious form of speed indicator, for automobiles, tramcars, &c., which it is claimed, offers advantages over apparatus already on the market for similar purposes, in respect of lightness, ease of fixing and accuracy. It consists of a magneto, driven off one of the wheels, and a hot-wire voltmeter connected to the magneto by means of a flexible wire, which forms the speed indicator. The indicator is of the watch pattern of instrument, 2 in. in diameter and 3 oz. in weight; it is preferably fitted on the steering wheel, so that it is always immediately under the eye of the driver. The dial is calibrated to indicate from 5 to 45 miles an hour, and as the needle is perfectly dead-beat, the speed indications can be read under the worst conditions of vibration. It may be added that the readings are equally accurate, whether the vehicle is running backwards or forwards. The magneto—weighing 1½ lbs. only—is arranged preferably for fixing on the steering horn of the front wheel, from which it is driven by means of a rubber band passed round a small aluminium pulley, fixed on the inside of the wheel. The armature consists of iron only, the coils in which the current is generated being placed inside the magneto, which is entirely waterproof. The indicator may, of course, be placed in any other position than on the steering pillar if desired, while the magneto may be driven from one of the hind wheels. The price of the apparatus is £4 15s. The indicator has been shown in France, at the Paris Salon, and also for a short time at the recent Crystal Palace Exhibition, in both of which places it attracted considerable attention.

Forthcoming Book.—Messrs. Crosby Lockwood & Son will shortly issue a new book by Mr. Wm. R. Bowker, entitled "Dynamo, Motor and Switchboard Circuits for Electrical Engineers, Artizans, and City and Guilds Students: A Practical Work Dealing with the Subject of Direct, Alternating and Polyphase Currents."

Arc Lamps at Olympia.—On the occasion of the International Wrestling Match between Hackenschmidt and Madrali at Olympia on 29th ult., the Palace Theatre, through its enterprising manager, Mr. Charles Morton, gave a piece of smart work in arc lamp installation into the hands of the Walsall Electrical Co. Mr. Hunt, London manager of the latter company, received an order for the installation of 40 1,000-c.p. open-type arc lamps at 1 p.m. on Friday, the 29th ult. The lamps were tested, packed, and sent to London by special goods van on passenger train, and were delivered at Olympia the same evening with all the cable and electrical sundries required. On arrival of the lamps at Olympia, the Palace Theatre staff took them in hand, and under the capable management of their chief engineer, Mr. Ison, everything was in readiness for the match three hours before the advertised time. The lamps were supported on a crescent-shaped iron tube, which itself was suspended from the roof by five steel wire ropes; separate wires were taken to each lamp, the wires being passed through insulators attached to the iron tube, and again supported in the centre of the span by passing through insulators attached to one of the battens, which was lowered for the purpose; the wires were then taken to the south gallery and made fast, after which each pair passed through a switch and cut-out, and then to the dynamo room. The Palace Theatre are to be congratulated on a very smart piece of work, and if they were not rewarded with the animated photo of the match, they at least had the thanks of thousands of sport-loving public for the most efficient lighting of the platform.

Private Bills in Parliament.—*Ealing Corporation Bill.*—On Friday the Parliamentary agents in charge of the Ealing Corporation Bill failed to appear before the Examiner, and the Bill was accordingly struck off the list. Amongst other things the Bill sought power to alter and repeal various provisions of the Ealing Electric Lighting Order so as to enable brackets, wires and apparatus to buildings; to enable the Corporation to supply electric energy to authorised supplying neighbouring authorities, and for tramway and light railway purposes, and further to enable the Corporation through a contractor to supply electric fittings, &c.

Standing Orders.—On Friday the Ilford U.D.C. Bill passed the Examiner in the House of Commons, and the following in the House of Lords:—Lancashire Electric Power, West Riding Tramways, and Tyneside Tramways and Tramroads.

Petitions.—Petitions have been deposited in the Private Bill Office of the House of Lords by the Great Eastern Railway, against the Yarmouth Corporation Bill; the Cheshire Lines Committee, against the Manchester Corporation Tramways; the Hammersmith Borough Council, against the Metropolitan District Railway; the L. & N. W. Railway Co., against the Portmadoc, Beddgelert and South Snowdon Railway; by Mr. C. H. B. Hesketh, against the Southport and Lytham Tramways; and by the Cheshire Lines Committee, against the Stretford U.D.C. Bill.

A large number of additional petitions have been deposited in the House of Commons Bill Office, including the following against Bills of electrical interest:—Baker Street and Waterloo Railway, by the Borough Councils of Paddington, Southwark and Marylebone, and the L.C.C.; Charing Cross, Euston and Hampstead Railway, by the L.C.C.; the Cheshire Electricity and Power Gas Bill, by the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board; Cheshire Lines Committee, Liverpool Corporation, Crewe Corporation, Stockport Corporation, Altrincham Gas Co. and the U.D.Cs of Bowdon and Wallasey; the East London and Lower Thames Electric Power Bill, by the Essex County County Council, the Great Eastern Railway Co., Thames Conservancy, London and India Docks, South-Eastern & Chatham Railways, the borough councils of Hackney, Deptford, Bermondsey, Camberwell and Poplar, and various urban district councils, and the South Metropolitan Gas Co.; to the Harrow Road and Paddington Tramways, by the Paddington Borough Council; to the Leyton Urban District Council (Tramways) Bill, by the Great Eastern Railway Co., Lea Bridge Gas Co., the Great Eastern London Suburban Tramways Co., the Lea Bridge, Leyton and Walthamstow Tramway Co. and others; to the Lincolnshire and Yorkshire Electric Power Bill, by the Derbyshire and Nottinghamshire Electric Power Co., the Scarborough Electric Supply Co., the Yorkshire Electric Power Co., the Corporations of Lincoln, Bridlington, Beverley, Grimsby and Harrogate, the U.D. Councils of Spalding, Scunthorpe, Glenford and Gainsborough, Cleethorpe and others; to the London, Camberwell and Dulwich Tramways, by the Camberwell Borough Council and the South Metropolitan Gas Co.; to the L.C.C. Tramways by the London, Camberwell and Dulwich Tramways Co., the London and Brighton Railway, the L. & N.W. Railway and others; to the London United Tramways, by the Surrey County Council, the Corporations of Ealing, Kingston and Richmond, and the U.D.Cs. of Esher, Slough, Surbiton, East and West Molesey and Acton, the Great Western Railway and others; to the London United Tramways (Railways), by the Hammersmith Borough Council, Barnes U.D.C., and the Thames Conservancy; to the Middlesbrough, Stockton-on-Tees and Thornaby Tramways, by the Middlesbrough Corporation, the North-Eastern Railway and others; to the North and South Woolwich Electric Railway, by the Great Eastern Railway, the Thames Conservancy, South Metropolitan Gas Co., and the Woolwich Borough Council; to the North-Western Electricity and Power Gas, by the North Staffordshire Railway, the G.W.R., London and North-Western Railway and four others; to the Plymouth Corporation Bill, by the G.W.R. Co.; to the Radcliffe Tramways and Improvement, by the Lancashire Electric Power Co., the Lancashire and Yorkshire Railway Co., Bury Corporation and others; to the Swindon Corporation Bill, by the Gloucester County Council, Swindon Gas Co. and two others; to the Torquay Tramways, by the Torquay Gas Co. and W. Harvey.

Later reports show that the following further petitions against electrical Bills have been deposited in the Private Bill Office of the House of Commons:—East London and Lower Thames Electric Power, by the Leyton U.D.C. and Messrs. A. Bruce & Co.; the Empire Electric Light and Power Co., the London Electric Supply Corporation, East London Waterworks Co., Electric Lighting Cos. of London, City Corporation, Metropolitan District Railway, Whitechapel and Bow Railway, West Ham Corporation; Swindon Corporation, by Messrs. Rolleston; Cheshire Electricity and Power Gas, by the Altrincham Electric Supply; North Staffordshire Railway, by R. J. Tellwright and others; Baker Street and Waterloo Railway, by the Metropolitan Railway Co. and the Lambeth Borough Council; Charing Cross, Euston and Hampstead Railway, by the Eastern Telegraph Co., Westminster City Council, and the Holborn Borough Council; Cheshire Electricity and Power Gas, by the Corporations of Manchester, Chester, Stalybridge, Hyde and Dukinfield and a number of U.D.Cs.; the Harrow Road and Paddington Tramways, by the L.C.C., Metropolitan Electric Supply Co., Gas Light and Coke Co., and the Grand Junction Water Co.; the Leyton U.D.C. Bill, by seven petitions, including the Walthamstow U.D.C.; Lincolnshire and Yorkshire Electric Power, by 17 petitioners, including the County Councils of the East Riding and North Riding of Yorks, and the Corporations of Kingston-upon-Hull, Ripon, Scarborough, Hull and Richmond; the London, Camberwell and Dulwich Tramways, by the L.C.C.; the Surrey Commercial Dock Co., and the Southwark and Vauxhall Water Co.; the L.C.C. (Tramways, &c.), by 22 petitioners, including the Charing Cross, Euston and Hampstead Railway, the Metropolitan District Railway, the Woolwich and South-East London Tramways Co., the Metropolitan Railway Co., the North Metropolitan Tramways Co., City Corporation, Westminster City Council, and the Borough Councils of Holborn, Wandsworth, Lambeth and Woolwich; the London United Tramways, by 19 petitioners, including the Middlesex County Council and a number of Urban District Councils; the London United Tramways (Railways), by the L.C.C., G.W. Railway, Metropolitan Railway, and three others; the Middlesbrough, Stockton-on-Tees, and Thornaby Tramways, by the North Riding County Council and two others; North and South Woolwich Railway, by the L.C.C., East London Waterworks Co., East Ham U.D.C., and others; the Radcliffe Tramways, by four private petitioners; St. Marylebone Electric Lighting, by the L.C.C., Metropolitan Electric Supply Co., and four others; the Soothill Nether U.D.C. Tramways, by the Wakefield and District Light Railway Co. and Yorkshire Electric Tramways Construction Syndicate, the Dewsbury Corporation, and G.N. Railway Co.; Watford and District Tramways, by the Hertfordshire C.C.; and Wolverhampton Corporation, by the Wolverhampton District Electric Tramways and the British Electric Traction Co.

In the House of Lords the following, amongst other petitions, have been deposited:—To the Belfast and North-East Ireland Electricity and Power Gas, by the Down County Council; to Holywood Tramways, by Down County Council; Manchester Corporation, by the Levenshulme and Whitefield Urban District Councils; to Newcastle-on-Tyne Corporation, by the Northumberland County Council and the Newburn U.D.C.; and to the Preston, Chorley and Horwich Tramways, by the Down County Council.

Scotch Bills.—The chairman of the Committees of the House of Lords and the chairman of Committees of the House of Commons have reported that they are of opinion that the Clyde Valley Electrical Power Order, the Govan (Burgh) Electricity Order, and the Lothians Electric Power Order ought to be dealt with by Private Bill and not by Provisional Order.

London United Tramways (Railways) Bill.—On Monday Mr. Jeune, one of the Examiners, had before him the London United Tramways (Railways) Bill for proof of compliance with standing orders. Mr. Pritt (Sherwood) & Co., Parliamentary agents, appeared for the company, and Mr. Brown (Dyson & Co.) represented the London County Council, who alleged that the Orders had not been complied with.

Mr. Brown said that the memorial of the L.C.C. alleged non-compliance of a considerable number of Standing Orders, but practically the one point to decide was whether the works described in the Bill were correctly described as railways, or whether they should not be described as tramways. The London United Tramways Co. had tramways both sides of the Thames, but at present no connection existed between the two, and the scheme of the Bill was to provide this connection by means of works, which were described in the Bill as railways. There were two so-called railways, one of which was entirely in Hammersmith, commencing under certain private property, and terminating upon the surface of the street in the Grove, with a junction with a tramway there. Railway No. 2 commenced in Lonsdale Road, Barnes, on the surface of the street, traversed the street for about 3 chains, and then went on to private property and proceeded through a tunnel under the Thames, where it joined Railway No. 1. Certain portions of the Railways Clauses Consolidation Act, 1845, were incorporated in the Bill, but other clauses were omitted, such as those referring to different classes of carriages, provisions of smoking accommodation, &c., but of course these omissions were only important as showing that it was a tramway and not a railway. There were certain disadvantages to promoters with regard to tramways, and it appeared to have been a brilliant inspiration of the company in this case to call them railways, as in the case of railways there was no question of obtaining the consent of the road authority, nor were there any provisions with regard to the purchase by the local authorities, or as to control by the local authorities of the rate of speed. It was obvious that these works were designed to form a connection between two systems of tramway, and that it was the intention to run through cars. It was a case analogous to that of the Fishguard and Rosslare Railway. In that case the promoters wished to connect two railways over a

public street, and contended that the connecting line was a level crossing, but that argument did not prevail with the Examiner. He submitted that there had seldom been a more obvious attempt to evade the Standing Orders applicable to tramways. If this was allowed to go through as a railway scheme, the word "tramway" would become unknown in those rooms, for every tramway proposed to be made along a street would be called a railway.

The Examiner said he had heard it stated that what a tramway was had never been defined. He would like to know if it had ever been laid down what a railway was.

Mr. Campion (the other Examiner) remarked that a tramway was generally associated with cars drawn on rails by horses. The character of tramways had altered till they were very much like railways, but there had been no definition of the word.

Mr. Pritt said he believed the first tramway was described as a street railway.

Mr. Brown said their contention was that these works so far as referred to rails on the surface of the street or road were tramways, and where not laid on the surface of the street, they were tramroads.

The question of the lines laid on the surface was taken, and Mr. Hedderstedt, one of the L.C.C. engineers, proved that 1½ chains of rail were on the surface of the street in the case of Railway No. 1, and 2½ chains in the case of Railway No. 2.

Mr. Jeune: Your contention is that it runs 1½ chains and 2½ chains along the public road, and the substantial part is that if this is a tramway, then the Standing Orders would be applicable?

Mr. Brown agreed that this was the chief point, but he alleged non-compliance in many particulars.

After some further argument, Mr. Jeune said there appeared to be no definition of what a railway or what a tramway was, and it was left to simple common sense to decide whether, as a matter of fact, this was a tramway or a railway. It appeared to him to be obviously a tramway, and he saw nothing to take it out of the Standing Orders applicable to tramways.

As the promoters were unable to prove compliance, the Bill will have to go before the Standing Orders Committee to decide whether it shall proceed.

London United Tramways Bill.—On Monday, this Bill, which proposes the construction of a large mileage of tramways in the counties of Middlesex and Surrey, was before Mr. Jeune, the Examiner. The promoters were unable to prove compliance, except in the case of over five miles of tramway in the Staines Road, and the Bill will have to go before the Standing Orders Committee to decide whether it shall proceed.

Bristol Tramways (Extension) Bill.—This Bill was before the Examiner of Standing Orders on Monday. Mr. Pritt (Sherwood and Sons) said that he was unable to produce the consents with regard to Warmley, with whom they were now negotiating, and would take a non-compliance with regard to tramways Nos. 4, 7 and 9. The Bill will thus go before the Standing Orders Committee.

Savoy Hotel and Theatre Electric Lighting.—The British Westinghouse Co. have just secured from the Savoy Hotel, Ltd., a further order, covering the supply of a 17-panel switchboard, a Tudor battery with a capacity of 700 ampere-hours, a 17½ KW. automatic reversible booster, one milking booster, and various other details. This plant has a total capacity of 900 KW., which will give some idea of the lighting and power requirements of a modern hotel and theatre. The switchboard, which is 34 ft. long and 7½ ft. high, and has 2 in. thick white marble panels, provides an effective means of inter-connecting the different circuits with either the private supply, or the mains of the Charing Cross Co.

Some Brush Contracts.—The Brush Electrical Engineering Co. has secured the following contracts:—

County of Durham Electric Power Supply Co.:—500 KW. steam dynamo consisting of 3-crank triple-expansion Brush-Falcon marine type enclosed engine with forced lubrication, direct coupled to 500—550 volt "Brush" generator.
Tyneside Tramways & Tramroads Co.:—Six double-deck car-bodies.
Paisley Tramways (per Mr. W. M. Murphy):—Twenty-five single trucks.

Robertson Lamp Fire Brigade.—The Sixth Annual Tournament of the London Private Fire Brigades Association was held on Saturday last, February 6th, at Shoreditch Baths. The Robertson Electric Lamp Private Fire Brigade, for the third year in succession, met with a considerable amount of success, the members of the Brigade winning a prize in every competition which they entered, and carrying off three first prizes, two second prizes, and one third prize. In addition to these prizes, the Brigade won the Championship for the whole of London, and are now holders of the Marshall Challenge Cup, which is given for the best all-round performance in all the competitions. The Brigade also hold the Hibbert Challenge Cup, for the best individual performance at the Tournament. These cups have both been wrested from the Railway Clearing House Fire Brigade, which has held the Championship of London for the last three years.

"New Gutta."—We understand that the New Gutta-Percha Co.'s product "New Gutta," is making its way steadily on the Continent. The Imperial Post Office of Germany have been using this material for the insulatian of submarine cable cores for some years past, and the Danish Government are now inviting tenders for a four-core submarine telephone cable 40 kilometres in length, on a specification which provides that "New Gutta" shall be used as the insulating material. We learn that the telegraph departments of other foreign Governments are taking up "New Gutta" seriously; the results of the extended tests to which this material has been put in everyday practical work by the Imperial Post Office of Germany having been satisfactory in every way.

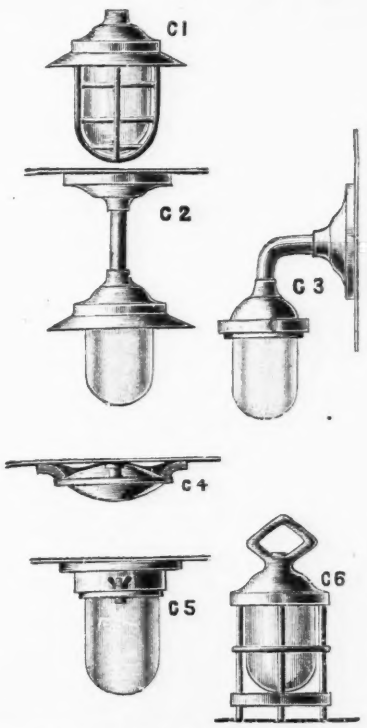
Electric Power Supply.—The Yorkshire Electric Power Co., whose undertaking is rapidly taking shape, has issued a nicely prepared brochure of some 20 pages, bringing forward the points respecting electric motors and power supply upon which likely consumers in its area will require information when considering proposals to change over from old forms of driving to electricity. A map of the excellent area of supply for which the company has powers, is given, and is followed by a concise recital of the advantages of electric motors, cost of power, and a number of illustrations of various classes of machinery adapted for electric driving.

We have also received a copy of *Electric Light and Power*, a new twopenny monthly magazine which is edited by Mr. George Offor, who has been associated with the electric supply industry for more than a quarter of a century. It is published by the Mendip Press, Ltd., of Amberley House, W.C., "by arrangement with suppliers of electricity under Acts of Parliament and Provisional Orders throughout the United Kingdom." The magazine will "furnish regular information to the public in towns where electric supply works have been established." The first issue seems to us to be admirably suited to the purpose which it has in view, and we wish it success in educating the local public in different towns respecting the great benefits which are accruing from the adoption of electricity in domestic and industrial life.

Catalogues and Calendars.—An attractively got-up circular has been issued by Erith's Engineering Co., of 70, Gracechurch Street, E.C., giving an outline description of their Sorge-Cochrane system of water-heating and purification for boiler feed.

Messrs. P. Walters & Co., of 249-251, Kensal Road, W., have issued an excellently arranged, well bound and clearly printed catalogue of their various telegraph and telephone instruments, railway signalling apparatus, batteries, linesmen's tools. Numerous illustrations of first-class description, show Morse instruments, sounders, relays, galvanometers, lightning protectors, switches, type-writing telegraph instruments, train-travelling and field apparatus, and such like specialities.

Messrs. Ward & Goldstone, of Strangeways, Manchester, have issued a new 4-pp. list of cast-iron watertight mill fittings, also ship fittings, hand lamps, and cast-iron and brass ring fittings and guards. The accompanying figures show some of their designs of these fittings for mining, mill and tramcar work.



Ward & Goldstone's Watertight Fittings.

Messrs. W. F. Dennis & Co., of 49, Queen Victoria Street, E.C., have issued to the trade a fourth edition of their "Fredennis" price list, and it contains details of several additions to their stocks, which are held in London, of bright drawn rods, copper and bronze wires, covered wires of various kinds, flexible cords for arc lamps, telephone instruments, &c. The contents of the list include wire, fencing accessories, wire ropes, sundries, covered wires, telephone batteries, bells, apparatus, &c., also prices.

"The Industrial Railway" is the title of a new catalogue which has been brought out by the C. W. Hunt Co., of New York. It gives a great number of pictures of narrow-gauge locomotives, steam and electric, tracks, turn-tables, and a variety of special tipping and other cars.

Mr. G. Braulik has issued a third edition of his list relating to miniature arc lamps.

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MESSRS. MARSHALL & WOODS, of Gray's Inn Road, have issued a 20 pp. catalogue illustrating their various classes of improved electrical apparatus for use in hospitals by surgeons and by scientific experimenters. Induction coils for X ray work, transformers for Tesla high frequency apparatus, Finsen light apparatus for lupus treatment, motor-alternators, regulating resistance boards, and many lines for electro-medical service, are shown and described, prices also being quoted.

An illustrated catalogue of improved friction and cage hoists for goods and passenger service, shafting, pulleys, &c., has been issued by MESSRS. WILLIAM WADSWORTH & SONS, School Hill, Bolton.

Cable Makers' Association.—The Anchor Cable Co. has just become a member of this Association. The other members are as follows:—

The British Insulated and Helsby Cables, Ltd.
Callender's Cable and Construction Co., Ltd.
Connolly Bros., Ltd.
The India-Rubber, Gutta-Percha and Telegraph Works, Ltd.
The London Electric Wire Co., Ltd.
Siemens Bros. & Co., Ltd.
W. T. Glover & Co., Ltd.
W. T. Henley's Telegraph Works Co., Ltd.

Callender's Hospital Fund.—We have before us a copy of the first annual report and financial statement of Callender's Hospital and Distress Fund, which was initiated at the Belvedere Works of Callender's Cable Co. on completion of, and with a part balance from, the late Reservists' Fund. It is very pleasing to note that, out of 1,398 employés no fewer than 1,376 are subscribers, and their payments during 1903 amounted to £289 odd. Special donations by the company and directors amounted to a further £81 10s. £210 of the receipts was disbursed to the hospitals and institutions which were regarded as most likely to benefit the members of the fund, including half-a-dozen hospitals, a Surgical Aid Society, the Hospital Saturday Fund, and two convalescent homes. Grants were also made to members who were in necessitous circumstances, to the tune of £39. Other large factories connected with the electrical engineering business might with advantage emulate so excellent an example as has been set at Callender's. We have no doubt that the hon. secretary, Mr. W. W. Jiggens, would be able to send a copy of the report and accounts to anyone who may wish for further particulars showing the lines upon which the fund is worked.

Meeting of Creditors.—A meeting of creditors of M'Aulay, Clark & M'Laren, of Glasgow, was held on the 15th inst., and a statement of affairs was submitted. It showed liabilities of £5,478, and assets (less £61 preferable claims) amounting to £1,813, leaving a deficiency of £3,665. A motion was unanimously adopted winding up the estate under the trust deed in favour of Mr. T. L. Anderson (Gibson & Anderson), 44, West George Street, Glasgow. An advisory committee was appointed, consisting of Mr. Rudd, of the British Insulated and Helsby Cables, Ltd.; Mr. M'Geoch, of William M'Geoch & Co., Ltd.; Mr. Taylor, of the Edison and Swan Co.; and Mr. Tidd, of Morris, Warden & Co.

Bankruptcy Proceedings.—The public examination was held last week before Mr. Registrar Hope at the London Bankruptcy Court, of Edward Hereford-Lavey and Ernest John Chapman, merchants and manufacturers' agents, trading as Hereford-Lavey & Chapman, at 9A, Grovenor Mansions, Victoria Street, Westminster. The statement of affairs discloses liabilities £5,813, and assets of uncertain value. In the course of his evidence, Mr. Hereford-Lavey stated that the partnership was entered into in January, 1901. During the following October they took over the sole agency and management of the Electric Lighting Boards (British Manufacturing Co.), Ltd. (now in liquidation), and granted sub-agencies to other persons in different parts of the country. In February, 1902, however, the company summarily determined the agreement with witness's firm, with the result that they were unable to carry out the sub-contracts. Their failure was entirely due to the withdrawal of the said agreement by the before-mentioned company, but immediately to the adverse result of two actions brought by the petitioning creditors for damages in respect of a sub-contract and for libel. The hearing was adjourned for further investigation of the accounts.

The first meeting of the creditors of Gardner Brothers & Co., electrical engineers, Burton-on-Trent, was held at Derby on Wednesday last week. Debtor's statement of affairs showed that the gross liabilities amounted to £2,860, of which £2,812 was expected to rank for dividend. The assets consisted of £32 for stock-in-trade, £58 for good book debts, and £10 15s. which bad and doubtfuls were estimated to produce, making a total of £101, but from this has to be deducted £48 for preferential creditors, leaving a deficiency of £2,759. Bad trade, losses on contracts and lack of capital were said to be causes of failure, and the estate was left in the hands of the Official Receiver.

E.C.C. Drawing Office Staff Dinner.—The members of the staff of the E.C.C. Drawing Office have a playful way of conviving, which gives promise of returning with the regularity of a recurring decimal. We are glad that vulgar f(r)actions are not admitted to these functions. The second annual dinner and smoker of the "paper spoilers" took place on February 13th, at the Talbot Hotel, Wolverhampton, Mr. S. Hawkins presiding. If the dinner was anything like as good as the menu, it must have been very successful. The menu in question is a very good skit on the card system (of indexes), and from it we gather that the various courses composing this "magnetic blow out," comprised, among other things, such delicacies as Sole (Plates), 37/16s Sausage, 600 Ω, Highfield Roosters (short-circuited), C. Current Plum-puddings and Regulators in the form of cheese, &c. This was followed by "diverters" at the concert held subsequently, where no doubt such topics as the "smoke question," "forced draughts," and "blown fuse(s)s," were ably discussed, and apparently it was a miracle that no "dead earths," accompanied by "temporary breakdowns," occurred, although, had they done so, the forethought which is so strongly in evidence in the E.C.C. Drawing Office, had provided "B.E." supports, P.C. 100, with a view to minimising risks. We shall look forward to the third edition of this menu with interest.

Book Notices.—*Report of the Select Committee on Ventilation*, 1903. London: Hickson, Ward & Co. 1904. Price 1s.—So universal is the lack of knowledge on ventilation, and so badly is this important matter usually provided for in the design of buildings (indeed, it usually seems to have been either forgotten altogether, or only remembered as an after-thought), that we think it worth while to draw attention to this reprint from a Blue Book, in the hope that it may be of service to our readers.

Street's Newspaper Directory. London: 8, Serle Street, W.C. 3s. 6d.—This work is conveniently classified, as usual, the alphabetical list of newspapers and magazines being placed first as an index to the contents in the other pages. Ampler details respecting newspapers, class and trade papers, magazines, are given in various sections. An interesting feature, as usual, is the newspaper maps of England, Wales, Scotland and Ireland, which show by different colourings the places which have one, two, three, or more newspapers.

"Transactions of the American Society of Mechanical Engineers, Vol. xxiv., 1903." New York: The Society.

"The Engineer's Year Book of Engineering Formulæ, Rules, Tables, Data and Memoranda, for 1904," by H. R. Kempe. London: Crosby Lockwood & Son. 8s.

"The Law Relating to the Telegraph, the Telephone and the Submarine Cable," by E. G. M. Carmichael. London: Knight and Co. 10s. 6d. net.

"The Common Sense of Municipal Trading," by Bernard Shaw. London: Archibald Constable & Co., Ltd. 2s. 6d.

"The Motoring Annual and Motorist's Year Book for 1904." London: *Motoring Illustrated*. 5s. net.

"Hie Europa! Hie Amerika! aus dem lande der Krassen Utilität," by Jul. H. West. Berlin: Franz Silmenroth.

"Introductions to the Study of Physical Chemistry," by Sir William Ramsey. London: Longmans, Green & Co. 1s. net.

"The Phase Rule and its Applications," by Alexander Findlay. London: Longmans, Green & Co. 5s.

"Directory and Statistics of Electric Lighting and Traction Works in the United Kingdom for 1904." Edited by C. S. Vesey Brown. London: Hazell, Watson & Viney, Ltd. 10s. 6d. net.

"O'Gorman's Motor Pocket-Book," by Mervyn O'Gorman. London: Archibald Constable & Co., Ltd. 7s. 6d. net.

"Die Anwendurg der Elektrizität für Militärische Zwecke," by Dr. Friedrich Wächter. Vienna and Leipzig: A. Hartleben. 3 k. 30 h., 3 m.

"Entropy; or, Thermodynamics from an Engineer's Standpoint," by James Swinburne. London: Archibald Constable & Co., Ltd. 4s. 6d. net.

Trade Announcements.—Owing to greatly extended business, the Lancashire Dynamo and Motor Co., Ltd., has removed its offices from Albert Chambers, 49, Queen Victoria Street, E.C., to Victoria Mansions, 28, Victoria Street, Westminster.

Messrs. Combe Barbour, Ltd., of Belfast, have appointed Messrs. Doddrell Bros., 11, Bothwell Street, Glasgow, as their agents in Scotland for the sale of Corliss steam engines, condenser plant and mill gearing.

Messrs. Frank Jordan & Co., of George Street, Mansion House, E.C., whose agreement with Messrs. Daniel Adamson & Co., of Dukinfield, expired on December 31st last, will henceforth act as sole agents for Messrs. Holdsworth & Sons, of Croft Boiler Works, Bradford, in London and the South-Eastern District, for the sale of their Lancashire, Cornish and vertical boilers. Messrs. Jordan's other agencies remain as formerly.

The Newton Electrical Works, Ltd., of Taunton, have altered their name to Newtons, Ltd.

Consequent upon the retirement, through ill-health, of Mr. Foxcroft from the firm of Foxcroft & Duncan, the business will be taken over by the junior partner, Mr. W. J. V. Duncan, who will continue the manufacture of the various well-known types of measuring instruments, switches, switchboards, arc lamps, &c., hitherto made by the firm, at the same address, Phœnix Works, 24, Queen's Road, Dalston, N.E.

Electrical Machinery Exports.—The value of the British electrical machinery exported from this country during last month amounted to only £33,726, as compared with £43,240 in the preceding month, and £42,029 in January, 1903.

Dissolutions and Liquidations.—A petition for winding up the Automatic Telephone Co. (1903), Ltd., is to be held on February 23rd. The company met on February 11th at Greenwich, under the presidency of Mr. Max Margowski, and passed a resolution for voluntary liquidation.

A receiving order has been made on creditors' petition against the Electrical Contracting and Maintenance Co., late of Ilford, whose present place of business cannot be ascertained.

Plant for Sale.—The Caledonian Railway Co. is offering various engines, dynamos, boilers, arc lamps, &c., for sale. Messrs. P. Huddleston & Co. are, on March 1st, to offer for sale by auction, the stock of an electric supply stores (Stewart Electrical Syndicate, in liquidation). Some particulars appear among our advertisements to-day.

LIGHTING AND POWER NOTES.

Bath.—In its report the E.L. Committee has decided to reject the proposal of Mr. Manville for the expenditure of a further £1,600 on extensions for next season's load, stating that the very heavy capital charges which the undertaking has already to bear must be kept within reasonable limits. Mr. Teague estimates that there will be an increased output of 110 KW. during next winter, making a total of 938 KW.

Beckenham.—The U.D.C. has decided to confine itself to an immediate expenditure of £2,000 on free wiring, and to reconsider the free wiring question when this amount is expended. A notice has been served upon the Crystal Palace Electric Light Co., requiring them to sell that part of their undertaking which is in the Council's area.

Brighton.—The E.L. Committee has recommended the T.C. to apply to the L.G.B. for a loan of £4,000 to cover the cost of completing the changing over to higher voltage.

Bristol.—The Electrical Committee has decided to purchase an electric service boat from the Thames Valley Launch Co. for conveying stores, machinery and staff between Avonmouth and Temple Back Works. Further extensions of mains have been decided upon.

Carnarvon.—The Corporation has resolved to present a petition against the North Wales Power and Traction Bill, the object being to exclude Carnarvon from the area in which the company propose to supply electricity. It was stated that the Council had already decided to support the Bill so far as it related to the proposed railway extension to the town.

Cauvery Falls.—According to the *Glasgow Herald*, the work of duplicating the plant at these falls is being carried out by the Mysore Government. The new water turbines are being supplied by Messrs. Escher, Wyss, of Zurich, and the generators by the General Electric Co., of New York; the steel water mains, sluices, valves, and other accessories are being provided by Messrs. Mechan and Sons, Glasgow. There are five new electrical units, the turbines being capable of developing 1,250 H.P. Each turbine has an independent supply pipe, which is expected to give much better results than in the original installation, where only one pipe for supplying each pair was fitted. The energy is to be transmitted at a potential of 35,000 volts. The extension involves a cost of £86,000.

Co. Down.—The C.C. has lodged petitions in Parliament against the Belfast and North-East of Ireland Electricity and Power Gas Bill and the Ulster Electric Power Bill.

Darlington.—The Corporation E.L. Committee on February 11th decided to reduce the price of energy for lighting by ½d. per unit, as from September next.

Dewsbury.—In regard to the charges of receiving a commission on oil, made against Mr. R. H. Campion, the borough electrical engineer, the matter has been investigated, and the charges found to be entirely without foundation.

Dorchester.—On the recommendation of its Electricity Committee, the T.C. has resolved to negotiate with private companies for the purpose of disposing of its electric lighting order.

Farnham.—The B. of T. has written intimating it proposes to revoke the Council's prov. order for electric lighting, but would be willing to consider any representations the Council might desire to offer on the matter. The U.D.C. has resolved to take no further action.

Golcar.—The Longwood Gas Co. and the Yorkshire Electric Power Co. are objecting to the extension of the Huddersfield electric lighting system to the district.

Gorton.—In view of the further prolongation of time from the B. of T. for the carrying out of its prov. order, the T.C. has resolved to endeavour to arrange terms with the Manchester Corporation for a supply of energy in bulk.

Greenock.—As the "fair wages" clause cannot possibly be enforced against firms offering machinery made in foreign countries, the Electricity Committee of the Corporation has decided, when calling for tenders, to ask for alternative offers for goods made solely by British manufacturers with British labour. Extensions to the generating plant are now being carried out.

Hampton.—The U.D.C. has asked the Twickenham and Teddington Electric Supply Co. to submit an estimate for street lighting by electricity.

Hove.—The L.G.B. has sanctioned the borrowing of £14,800 by the T.C., for electric lighting purposes.

Huddersfield.—The Borough Treasurer's revenue statement, presented to the Electricity Committee, shows an income for the past year of £26,006, compared with £23,160 last year. The expenditure has amounted to £12,627, as against £10,404 in the previous year, leaving a surplus of £13,378. £4,680 has been allowed for interest on loans, repaying £1,291 to the Public Works Loans Board, £3,492 towards the redemption of the debt, and the balance of £3,915 has been transferred to the depreciation and contingencies account, which now amounts to £11,854 11s. 7d.

On 11th inst. a breakdown occurred at the electricity works, owing to an obstruction in the boiler feed pipes. The fires had to be withdrawn to avoid an explosion. Considerable inconvenience was caused to the public, the town being in darkness for about two hours. The tramways were not affected, the supply of energy being taken from the tramway power station at Longroyd Bridge.

Ilford.—The U.D.C. has made the following reductions in the price of energy:—Flat rate, from 5d. per unit to 4½d.; maximum demand to 6d. and 2d.; public lighting, from £4 5s. per annum to £4 per 25-C.P. incandescent lamp.

Ince.—The U.D.C. has decided to circularise the ratepayers asking if they will use electricity if provided by the Council. The extension of time granted by the B. of T. will soon expire.

Kesteven.—The County Council has decided to petition against the Bill of the Lincolnshire and Yorkshire Electric Power Co.

Leigh.—The resolution passed by the T.C. recently, and referred to in our issue of last week, to engage an expert electrical engineer to examine the whole of the electrical undertaking, in no way reflects on the resident electrical engineer. The decision to obtain expert advice is the result of a report drawn up by the borough electrical engineer on the unsatisfactory condition of the works owing to mistakes in the initial stages of the undertaking, and also the unsuitability of the present site for further extensions.

Lincolnshire and Yorkshire Electric Power Scheme.—Another local authority, the Cleethorpes U.D.C., has resolved to present a petition against this scheme.

London.—MARYLEBONE.—The L.C.C. has informed the B.C. that it is desirous of placing as little difficulty as possible in the way of the Council in regard to its Bill; but in view of the near approach of the time for depositing petitions, the L.C.C. are obliged to deposit one, in order to secure certain amendments to safeguard its position.

SOUTHWARK.—An inquiry was held upon the 18th inst., as a result of an application made to the Council to prepare a scheme providing that the expenses of the Newington electric lighting undertaking shall become chargeable on the whole borough.

BETHNAL GREEN.—The Electricity Committee of the B.C. has appointed two delegates to attend the conference convened by the Hackney B.C., on the subject of municipal undertakers, wiring consumers' premises.

WESTMINSTER.—The Law and Parliamentary Committee of the City Council reported the receipt of a letter from the Hackney B.C. stating that, in carrying out its electric lighting undertaking, it entered into an agreement with the National Electric Wiring Co. for the wiring and fitting of consumers' premises under a "Rental Wiring System;" that the company terminated the agreement in September last, since which time a number of prospective consumers had been lost owing to the inability of the Council to continue the rental wiring system, or to find contractors willing to put their capital into that class of business; reminding the City Council that the L.C.C. endeavoured to obtain powers for the B.C. to borrow money for free or rental wiring schemes, and that the Bill was strongly opposed and defeated; and that the opponents to the measure had since intimated their intention of not renewing their opposition should the matter again come before Parliament.

ST. PANCRAS.—The B.C. has called upon the Electricity Committee and the Works Committee to bring up separate reports setting out the whole facts in Colwell and Others *v.* the B.C. case.

At a special meeting held on 17th inst. to consider what steps should be taken upon the judgment in the action with respect to vibration from the electricity works, the electrical engineer reported that after conference with various experts, he could only state that were the works again in contemplation it would not be possible to do anything else with regard to the choice of plant than what had been done in the past. The whole of the trouble appeared to be in the subsoil, and this could not be ascertained in any case before installing the plant. To go to the base of the trouble it is necessary that the engines should be absolutely balanced. The engines as installed are those supplied as a commercial engine, and it is not the usual practice to balance them beyond a certain extent. Prof. Dalby, in conjunction with the makers, is investigating the matter. A special committee has been appointed to deal with the matter.

FULHAM.—The Prudential Assurance Co. has arranged to lend £25,000 to the B.C. for electric lighting purposes at 3½ per cent interest, as against 3¾ charged at present by the L.C.C.

STEPNEY.—A loan of £1,998 from the L.C.C. for electric lighting purposes has been taken up by the B.C.

STOKE NEWINGTON.—On Tuesday the B.C. appointed Messrs. E. Talbot and A. D. Stevenson, consulting electrical engineers, *vice* Messrs. Hopkinsons & Talbot, who have dissolved partnership.

EAST HAM.—Sanction has been received by the U.D.C. from the L.G.B. to borrow £14,430 for additional electric lighting plant. Katherine Road is to be lighted with arc lamps at an estimated capital outlay of £1,206.

SHOREDITCH.—On 16th inst. the B.C. decided to ask the L.C.C. to sanction a loan of £14,069 for electric lighting purposes.

Newton Abbot.—The U.D.C. has assented to the Newton Urban Electricity Co. applying for a prov. order to extend its powers to Kingsteignton.

Northampton.—The R.D.C. has agreed to assent to the Northampton Electric Lighting Co. supplying energy in its district, providing the company charges the same terms as to the borough. The company states that it cannot consent to such terms, as the laying of mains to the outlying districts would involve a much larger outlay, and has asked the B. of T. to dispense with the consent of the Council to the order.

Oldham.—The Electricity Department of the Corporation has resolved, subject to the approval of the Council, to arrange with Messrs. Veritys, Ltd., for the opening of showrooms for electrical appliances, such as motors, radiators for heating, cookers, &c. These will be offered to the public either for hire or purchase, to suit the requirements of the user. The charge for energy for power purposes in Oldham being 2d. per unit for the first 500 units used, 1¾d. for the second 500, and 1½d. per unit for all over 1,000, at which price the cost to the user compares favourably with that of gas or steam power.

Oxford.—As a result of an accumulation of gas, which became ignited by some unknown means, in a mains inspection chamber of the Oxford Electric Co., an explosion occurred recently, hurling three of the chamber covers in Mill Street, together with a considerable quantity of brick pavement, &c., into the air.

Perth.—The electrical engineer has reported that in order to be in a position to supply energy for the tramways, the following additional plant will be required:—One 420-KW. steam dynamo, £4,500; tramway switchboard, &c., and additions to present switchboard, £2,150; total, £6,650. The feeder cables supplying the town being fully loaded, it would be advisable to lay an additional feeder from the works to the top of Kinnoull Street at an estimated expenditure of £1,650. The estimated expenditure immediately required is therefore £8,300. In order to meet any extension of lighting as well as tramways, which will be likely to take place within the next five years, the following additional plant will be required:—

Additional generating plant	£5,300
Water-tube boiler and feed pumps	1,250
Condensing plant	1,100
Distributing cables	1,550
Meters, cut-outs, &c.	1,200
	£10,400
Add for contingencies	1,300
	£11,700
Add estimated immediate expenditure	8,300
	£20,000

Pleasley.—The P.C. has signed an agreement with the Shirebrook Colliery Co. for lighting the district by electricity.

Plymouth.—The return for the nine months' working of the electricity undertaking, ended December 31st last, and recently submitted to the T.C., show a net profit of £1,634. Further extensions of plant are stated to be necessary.

Richmond (Yorks.).—The T.C. has resolved to petition against the Lincolnshire and Yorkshire Electric Power Bill.

Romford.—The U.D.C. has resolved to offer no opposition to the Bill being promoted by the East London and Lower Thames Electric Light and Power Co.

Spain.—A generating station has just been completed and put into operation at Figueias (Province of Gerona). Water-power is utilised, the plant comprising two turbine sets, one of 100 H.P., and one of 200 H.P.

Tunstall.—The U.D.C. has been advised that it can only obtain energy in bulk from Burslem Corporation by means of a special Bill in Parliament. Neither Council possesses powers to supply energy to Tunstall, but the latter Council has decided to ask the L.G.B. if there is any reason why energy should not be supplied in bulk by Burslem.

Widnes.—The T.C. has decided to apply for an extension of the E.L. order obtained in 1901, with special provision for transfer, and to delegate the powers under the order to the Mersey Electric Supply Co.

Wimbledon.—At Kingston-on-Thames on February 11th, the Wimbledon U.D.C. appealed against the assessment of the E.L. works, which had been placed at £4,857 gross and £2,500 net, an increase of £1,439 and £1,300 respectively. The Assessment Committee reduced the net assessment to £1,700.

Windsor.—The T.C. has signed a further agreement with the Electrical Installation Co. for the public lighting of the town for another five years, the previous agreement with the company being about to expire.

TRAMWAY AND RAILWAY NOTES.

Bath.—The ceremonial opening of the electric tramways took place on Saturday, the 13th inst. The line at Combe Down still has to be completed, but with the exception of this piece (about 1½ miles), the whole of the sections have been in operation since the beginning of the year. The directors of the company, however, decided to postpone the formal opening until their power house and other parts of their system were complete. The line along Combe Down will not be ready for some time, although part of it is laid, but it was resolved that the ceremony should not be further deferred on account of this unfinished bit of the system. Members of the Bath Corporation, representatives of outside authorities (the tramways extend considerably beyond the municipal limits), and others assembled at the company's headquarters in Walcot Street at one o'clock, and inspected the car-shed, boiler house and engine room, and half-an-hour later a procession of cars moved off towards the Guildhall. On the first of these Lady Caillard, the wife of the chairman of the company, had taken the driver's position, some little time having previously been occupied in instructing her ladyship in the use of the controller handle, the brake lever and the gong. Before the car left the shed in charge of its fair driver, Lady Caillard expressed the pleasure it gave her to declare the Bath electric tramways open, and wished the undertaking great success. When the applause subsided, Sir James Sivewright, one of the directorate, thanked her Ladyship on behalf of the company, and presented her with a silver bon-bon box as a souvenir of the occasion.

The short run to the Guildhall was without incident, and in the fine banquetting room of that building, about 160 guests were entertained to lunch by the company. Sir Vincent Caillard presided, and supporting him were the Mayor (Major Simpson), Sir James Sivewright, Lady Sivewright, Lady Fairbairn, Lady Caillard, the Mayoress, Mrs. Hugh Clutterbuck, Messrs. H. F. Clutterbuck, and A. A. Campbell Swinton (directors), E. W. R. Trenow (managing director), J. E. Huxtable (solicitor to the company), W. B. Hopkins, W. A. Harper, and H. W. Harper (engineers of the scheme), R. D. McCarter (manager and engineer to the company), W. E. Hardy, S. G. Belcher, R. H. Pearson, L. H. Dolman, J. C. Warner, M. A. Harding, A. W. Sealy (members of the company's staff), and many others.

The speech-making occupied but a short time. Following the toasts of "The King" and "The Queen, the Prince and Princess of Wales and Other Members of the Royal Family," was that of "Prosperity to the Bath Electric Tramways Co., Ltd."

The Chairman replied.

Sir James Sivewright proposed "The City and Trade of Bath."

The Mayor briefly replied, and Alderman Taylor, the chairman of the Committee of the Corporation which had had the matter in hand, spoke in response to repeated calls.

Berlin—Hamburg Express Electric Railway.—Although the high speed electric railway experiments on the military railway between Marienfeld and Zossen, which were suspended a short time ago, after speeds ranging up to 131 miles an hour had been attained, have led to various suggestions in regard to the establishment of an express electric railway between Berlin and Hamburg, it is only now that definite schemes have been elaborated for the construction of the proposed lines. Two projects for this purpose have just been placed before the Government, and it is expected that an early decision will be arrived at in respect of one, notwithstanding the fact that the Imperial Home Office authorities have not yet invited the promoters to meet in conference on the subject. The two schemes are very similar in character, and both propose the erection of a central electric power generating station at Wittenberg, while one only contemplates the use of the existing railway stations along the route for the purpose of the railway. At present the traffic between Berlin and Hamburg has become so heavy that the laying of a third track has become necessary for the steam trains, but the expenditure in this direction would be obviated in the event of one of the two plans in question receiving the approval of the Government. The journey between the German capital and Hamburg is now accomplished by express trains in three hours, but each of the electric schemes provides for the duration of the run being reduced to one hour and a half.

Birmingham.—The Tramway Committee on 16th inst. further considered the drafting of a scheme for the extension of the electric tramway system to districts not already served. It is hoped that a suitable scheme will be formulated in time for a Bill to be lodged this autumn. The problem presents some difficulty owing to the apparent intention of the authorities not to cater for through passengers, the physical difficulties, such as gradients, and the determined opposition on the part of residents in Edgbaston to trams in their neighbourhood.

Bournemouth.—The T.C., sitting as a Committee on February 2nd, discussed the question of recognising the services rendered by the borough engineer (Mr. F. W. Lacey) in connection with the tramways schemes. It is understood that the committee decided to recommend to the Council the grant of a lump sum of £750, in addition to an increase of salary of £50 per annum until it reaches £1,000.

Bristol.—The annual supper given by the Bristol Tramway Co. on Tuesday night to their 1,500 employés produced an important announcement by Mr. George White, the chairman, with regard to a pension scheme, which will now come into operation. Several years ago Mr. White expressed the hope that arrangements might be made in this direction, and in the interval the directors have voted £6,500 to the scheme, while Messrs. George and Samuel White have privately subscribed £2,500. It was, however, understood that the operation of the pension system would be deferred until the fund reached £10,000. Mr. George White on Tuesday explained that, to prevent further delay, his brother and he were providing the remainder. The directors also, he might tell them, had resolved to increase the annual subscription from £1,000

to £1,500. It had been his desire, Mr. White said, to do for the tramway company's men something better than was done by the railway companies. The plan to be adopted was this:—Men were at liberty to retire at 65 years of age, and if they had completed 25 years' continual service with the company, they would receive a pension amounting to half the wages paid at the time of their retirement. That was the minimum. The rate of pension would be increased with longer service. For instance, if a car driver at 65, retired after more than 25 years' service, but less than 30, his wages were 30s.; his pension would be 15s. for the rest of his life; 30 years' service would add 1s. 6d., and so on. Retirement would be optional. The announcement was received with great enthusiasm. Mr. Samuel White, who also addressed the meeting, mentioned that the company's Provident Society had already paid out £11,156 in sick and funeral benefits.

Bury.—The T.C. has received a communication from the Radcliffe U.D.C., stating that at the recent conferences with regard to the tramways in that district, it was suggested that the Bury T.C. electrical engineer would be willing to supervise the working of its electricity works when completed. The T.C. has appointed four members of its Electricity Committee to confer with the Radcliffe U.D.C. in reference to the proposal.

Carnarvonshire.—The North Wales Power and Traction Co.'s scheme involves the construction of a light railway from the seaport of Portmadoc through the romantic village of Beddgelert on to Snowdon, and thus joining the North Wales narrow gauge railway, which runs on to Dinas, situate three miles from Carnarvon town. The latter railway is also to be extended to Carnarvon, and in this way a new route of 23 miles from Carnarvon to Portmadoc will be afforded as an alternative to the 28-mile route and a break of journey along the L. and N.W. and the Cambrian Railways. The scheme also intends the construction of a light railway from Beddgelert to Bettwsycoed, 14 miles away. The whole project is based on the generation of electrical energy at a low cost by means of water-power from lakes on the Snowdon mountain. One-fifth of the available water-power will be adequate for the railways; the remainder is to be devoted to the electrification of the towns and quarries in the district, and probably to the supplying of energy in bulk to other railway companies. The scheme was unfolded at inquiries held by the Light Railway Commissioners at Beddgelert and Bettwsycoed some days ago, and Sir Douglas Fox, consulting engineer to the promoters, gave evidence. Opposition was offered by the Bettwsycoed Urban Council, the National Trust for Places of Beauty and Historic Interest, and others; but the Commissioners announced that they will submit an order for confirmation by the Board of Trade. In framing the order special powers would be taken to ensure the renowned scenery of the district through which the railways will run. The promoters announced that the contracts for the different works had been placed, and that the contractors were ready to start at once.

Colwyn Bay.—It is reported that Messrs. Hewitt and Rhodes, engineers to the Colwyn Bay Light Railway Co., have entered into a contract for the construction of the line from the North-Western Hotel, Llandudno, to Rhos-on-Sea, and that the work is to be completed by May 1st. About a mile and a-half of the permanent way is laid on this section. Work under the new contract is to commence in the course of the coming week.

Dudley.—An unusual accident took place on the tramway last week. A Cradley Heath car was in the siding, near the Fountain, Market Place, and when it was about due out the conductor released the brake without observing that the motor-man was absent from his place in front of the car, which was thus set in motion. It travelled without the motor-man a considerable distance, and dashed into the rear of a cart and injured the horse.

East Cheshire.—The Light Railway Commissioners held an inquiry at Stalybridge on 10th inst. with reference to an application by the East Cheshire Light Railways Syndicate, Ltd., for power to construct a light railway from Mottram to connect with the electric tramways at Stalybridge and Hyde, and running also to Broadbottom and Tintwistle. It was stated to be the syndicate's intention to construct seven miles of tramways at an estimated cost of £80,000. This figure included £10,000 for the erection of a generating station; but this, it was said, might not be needed. It takes 1 hour 40 minutes to get by rail from Stalybridge to Glossop, and the fare is 8½d., whilst by the proposed tramway the journey would be accomplished in 35 minutes at a fare of 6d. The scheme was opposed by the Great Central Railway Co., who pleaded that it would seriously injure their undertaking. Already their traffic receipts in the Glossop district had been reduced 72 per cent. by the tramway competition. In the end, the Commissioners found that there would be sufficient interference by the proposed scheme with the traffic of the Great Central Railway Co. to remove the case from their jurisdiction. It remains for the syndicate now to seek Parliamentary powers.

Exeter.—Last week the City Council discussed the proposal to construct 12 single-track miles of electric tramways, mainly on the point whether the overhead trolley, conduit, or surface contact system should be adopted for the central parts of the route, through the narrow business thoroughfares. A combined system of conduits for the central parts, and trolley for the outskirts was suggested, but for the shortest proposed length of conduit the additional annual cost per annum for repayment of capital and interest would be £600; and it was finally agreed that the trolley be used over the whole system. Tenders are to be immediately invited for the construction of about four miles of track.

Glasgow.—Two men have been injured here through a live trolley wire falling. The men were seated on a 'bus when the wire fell. One of the men received a superficial wound below the knee, and the other a burn 3 in. long on the right thigh. In addition they suffered from shock, and after being medically attended to were removed home in cabs. Little delay was caused to the traffic, as the breakdown squad of the Corporation were soon on the scene and repaired the defect.

Great Northern and City Railway.—This new electric railway was opened for traffic last Sunday.

King's Norton and Northfield.—The U.D.C. is pushing forward with the construction of tramways between the Birmingham boundary and King's Norton, along the Pershore Road. The permanent way is now being rapidly laid. It is proposed to divide the distance into three 1d. stages, and put six or eight cars on the route; power may be had from the City of Birmingham Tram Co.'s power station at Bournbrook, which at present supplies the Bristol Road route of the Birmingham system.

L. and Y. Railway and Tramway Competition.—The railway lines having termini in Manchester are feeling the effects of tramway competition rather keenly. The chairman of the Lancashire and Yorkshire Co. (Sir G. Armytage), at the half-yearly meeting last week, referred to this matter as one of rather serious importance. There had, he said, been a net decrease in the passenger department of £26,153, and of this it was estimated that tramway competition was responsible for not less than £22,000. The chairman of the Great Central Railway Co., spoke in a similar strain at the shareholders' meeting of that company. Comparing the December half of 1903 with the same half of 1901, he said they had lost no fewer than three-quarters of a million passengers, who formerly availed themselves of the suburban services of the Great Central. The actual money received for those short journeys was not great, but still the money they had lost from these passengers—about £4,000 in the last half-year—had been practically a net loss to them, as it had not been possible to materially reduce their train services. On several lines of railway round Manchester large reductions of suburban fares are anticipated in the near future.

Liverpool.—Sir Charles Petrie, when speaking upon the estimates of the Tramways Committee in the Liverpool City Council, stated that the traffic returns showed that 113,057,234 passengers were carried last year—an increase of 3·40 per cent. on 1902, and of 194·35 per cent. over 1897, the last year of the old company's management. No collision of a serious nature had occurred, and the fatalities had fallen to 1 in 28,000,000, as against 1 in 13,000,000 in 1902. This was attributed in a large measure to the use of the plough life-guard. The total income last year amounted to £531,483—an increase of £18,058 over 1902. The expenditure during 1903 amounted to £341,484, against £339,811 in 1902—an increase of £1,652. The car-mile earnings increased from 10·34d. in 1902 to 10·73d. in 1903—an increase of ·39d. per car-mile. The percentage of working costs to revenue had fallen from 65 per cent., in 1902, to 64·24 per cent. in 1903. The gross profits had risen from £178,124, in 1902, to £203,256, in 1903—an increase of £25,133, equal to 10·9 per cent. on the capital expenditure, compared with 9·7 in 1902. The net profit was £96,242, against £75,497 in 1902—an increase of £20,745.

Liverpool and Southport Electric Railway.—More tangible signs are now evident of the approaching inauguration of the new electric service between Liverpool and Southport. Several of the new carriages arrive weekly from the L. & Y. Co.'s works at Newton Heath, and the railway authorities have selected the drivers from among the locomotive firemen at present at Sandhills and Southport. On the 14th inst. several very successful trials were made over the complete line from Liverpool to Southport, the tests being carried out without the slightest hitch, while the speed at certain points on the journey was greatly accelerated with the most satisfactory results. The new service will be inaugurated some time next month (March), when the company will have received the full complement of coaches from the builders.

London.—L.C.C.—At the meeting on Tuesday, five tenders were received for the supply of fuel economisers for the Greenwich power station. The tenders were referred to committee for consideration. Mr. Austin—on the motion for the reception of the report of the Highways Committee—asked whether the attention of Mr. Benn had been drawn to a statement made by the chairman of the North Metropolitan Tramways Co. to the effect that given fair play, the Council would find the directors ready and willing to redeem their promises in regard to the adoption of electric traction. Mr. Goodrich desired to know whether the cost per car-mile run by the electric cars had been ascertained, and whether the cost of the burnt-out ploughs was charged to capital or revenue account. Mr. J. W. Benn, in reply to Mr. Austin, read a statement on the subject of the proposed conversion of the northern lines, in the course of which he remarked that the company had had full opportunity for considering the question, and that if the company had been disposed to forward the introduction of electric traction, portions of the lines, if not completed, would at all events have been far advanced by the present time. With regard to the cost of electric traction, the Committee were not prepared until the accounts were made up at the end of the year to inform the Council of the cost per mile run. It must not be assumed that the cost exceeded the estimate placed before the Council. The expenditure on the new ploughs would be provided for out of the maintenance account.

The Highways Committee reported that it had been found necessary to employ district inspectors on the various sections of the conduit tramways with a view to ensuring the efficient working of

the lines. The duties of the men consist in taking steps, as far as possible, to prevent accidents arising from defective ploughs, &c., and when such accidents occur to immediately take measures for the location of the faults and the restoration of the tramway traffic. Down to the present time five district inspectors had been engaged, but no rate of pay had been fixed by the Council for that class of work. On the recommendation of the Committee, the Council fixed the rate at 45s. per week.

The Committee stated that it had not been possible to obtain the promise of the contributions required from the local authorities towards the cost of widening roads in connection with the proposed tramways from Clapham Common to East Hill, Wandsworth, and from Deptford to the Herbert Hospital, Woolwich. In these circumstances, the Committee recommended, and the Council agreed, not to proceed any further with the application to Parliament for powers to construct the tramways in question in so far as the present session is concerned.

NORTH METROPOLITAN TRAMWAYS CO.—At the half-yearly meeting of the company, Mr. George Richardson, the chairman, referred to the attitude of the L.C.C. as to the "electrification" of the lines leased to this company—the lines always referred to by the Council and in the newspapers as the "Council's Northern Tramways." It was quite true that they had demurred to the introduction of the conduit system, but it was not fair to suggest that they had done more than that, or that they had refused to co-operate or assist the Council in the matter. The directors had in no way changed their views that the overhead system of traction could be more rapidly and economically established than was possible with the conduit system, with the minimum amount of disturbance and inconvenience to the public.

WANDSWORTH.—The L.C.C. has informed the B.C. that in view of the decision of the latter body not to contribute one-third the cost of the necessary street widenings, the proposed tramways from the existing terminus at Streatham to the County boundary, and from Clapham to Wandsworth, will not be proceeded with.

Manchester and Ashton.—An agreement has been arrived at between the Corporations of Manchester and Ashton-under-Lyne for the running of a 10-minutes' service of electric cars between Audenshaw and Ashton by the cars running to and from Manchester by way of Ashton old road; but passengers using the Droylsden cars will require to change at Audenshaw. The Ashton proposal that the term of the agreement should be for three years has been accepted by Manchester.

Manchester to Liverpool.—At Little Hulton, near Bolton, work was begun last week on the stretch of new tramway line, which will be a link in the through tramway service between Liverpool and Manchester. Some 50 or 60 industrial towns and urban districts will ultimately be linked up. The junction with the Manchester—Salford tramway system will be effected at Swinton.

Paisley.—The conversion of the tramway system from horse haulage to electric traction is being proceeded with rapidly. By the end of the present month, it is expected that the eastern portion of the line to the Glasgow terminus, will be ready for opening. In a letter from Mr. Murphy's electrical engineer to the T.C., he states that every effort is being made to have the Johnstone route open for traffic in April. Until the track in the eastern portion of the line is laid with cables, the T.C. has been asked whether it will be agreeable to Glasgow supplying the power, so that the Glasgow cars may be enabled to run into the Cross at the earliest possible moment. The request has been acceded to on the understanding that the current would be taken from the Paisley electricity works not later than April 1st next.

Pemberton.—The L.G.B. has given the U.D.C. sanction to borrow £16,155, which will be expended as follows:—Generating station plant, £8,200; Ormskirk Road tramway, including overhead equipment and cables, £3,355; Warrington Road tramway, including equipment and cables, £4,600.

Perth.—The report by the electrical engineer as to the new plant required in order to electrically equip the tramway service states that it will be necessary to provide one 420-KW. steam dynamo with foundations, £4,500; one fan for induced draught, £500; tramway switchboard, £1,400; additions to present switchboard, £250. As the feeder cables at present supplying the town are now fully loaded, it would be advisable to lay an additional feeder from the works to the top of Kinnoul Street, at an estimated expenditure of £1,650. The estimated expenditure immediately required was, therefore, £8,300. In order to meet any extension of lighting as well as tramways which will be likely to take place within the next five years, the following additional plant will be required:—Generating plant, £5,300; water-tube boiler and feed pump, £1,250; surface condensing plant, £1,100; distributing cables, £1,550; meters, cut-outs, &c., £1,200—£10,400 in all, with £1,300 for contingencies.

Rochester.—The tramways are now to be proceeded with at once. Mr. Rotter (the Council's engineer) has laid before the Committee a draft specification to be attached to the contract in respect of the permanent way and the overhead equipment of the section from the City boundary over the New Road and on to Star Hill, and it has been approved by the Corporation, which is to lay down the lines to be in turn leased by the Chatham and District Light Railways Co., who are now running electric trams all over the adjoining towns of Chatham and Brompton.

Stockport.—The T.C. had a meeting last week to consider the position of the tramway undertaking. The Mayor and several members of the Tramway Committee had previously resigned in consequence of the rejection of the Committee's proposal to appoint Mr. A. T. Eardley, the Committee's clerk, as tramway manager, at a salary of £300 a year. The result of a long discussion was, that Mr. Eardley's appointment was confirmed, but the salary attaching to the post was reduced from £300 to £250. The chairman and vice-chairman of the Committee, at the request of the Council, withdrew their resignations.

Tramway Statistics.—The Parliamentary return which has just been issued, showing the particulars of "Street and Road Tramways and Light Railways" in the United Kingdom up to June 30th, 1903, is an interesting document. The figures speak very eloquently of the progress of electric tramway traction, and in the main are as follows:—

Number of undertakings	296 with 1,772 track miles.
Municipal undertakings	142 with 1,067½ track miles.
Other undertakings	154 with 704½ track miles.

Method of Traction:—

	Miles.	Chains.
Electric	1,258	33
Steam	140	22
Cable	30	18
Gas motors	9	45
Horse	333	59
	1,772	17

The following figures show the progress during the year:—

	1902.	1903.
Total capital expended	£31,562,267	£41,656,597
Miles open	1,484	1,772
Number of horses	24,120	20,005
Number of loco. engines	382	334
Number of cars	7,755	8,951
Miles run	—	178,684,280
Passengers carried	1,394,452,983	1,681,948,655
Gross receipts	£6,679,291	£8,080,042
Working expenses	£4,817,873	£5,511,259
Net receipts	£1,861,418	£2,578,783

The return is divided up into two parts: (1) Giving details as to capital authorised for and expended upon each undertaking, and the length of line; and (2) showing fully the gross receipts, working expenditure, net receipts, passengers carried, miles run, passengers, and so on in respect of each of the 296 undertakings.

Whitechapel and Bow Railway.—At the meeting of this company last week the chairman, Mr. H. Doughty Browne, said it was hoped that the work of "electrification" would be carried out simultaneously by the District Co. and the Tilbury Co. Up to the present time the company had been unable to get any through service in connection with the Metropolitan Railway. When the company's line was made the theory was that there would be almost as valuable traffic to be received from the north branch as from the south branch, over the Metropolitan District.

Wigan.—The T.C. has disposed of 12 of the old tramcars to the New General Traction Co., Ltd., for £4,000.

TELEGRAPH AND TELEPHONE NOTES.

Swansea Telephones.—At the last meeting of the Telephones Committee, it was reported that many new orders were being received, and the chairman said they would shortly require more money to proceed with the scheme. It was stated that £20,300 had so far been spent, and Mr. Mackie, manager, said that, roughly, about £15,000 more would be necessary to double the system. It was decided to recommend the raising of a loan for the purpose.

Glasgow Telephones.—Ambulance classes have been inaugurated in connection with the National Telephone Co. (Glasgow district). Fully 160 employés, male and female, are being taught "first aid to the injured."

Telegraphic Interruptions and Repairs:—

CABLES.	INTERRUPTED.	REPAIRED.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1903	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Tarifa-Tangier	Jan. 18, 1904	
Oran-Tangier	Feb. 3, 1904	
Nagasaki-Vladivostock	Feb. 15, 1904	

CONTRACTS OPEN AND CLOSED.

OPEN.

Aston Manor.—February 23rd. One 750-KW. steam dynamo. See "Official Notices" February 12th.

Austria.—March 20th. The Municipal Authorities of Retz are inviting tenders until March 20th for the establishment of a central electric lighting station in the town.

Battersea.—February 22nd. Coal, stores, carbons and meters for the Electricity Department. See "Official Notices" February 12th.

Bermondsey.—March 1st. Wiring of buildings, &c., at the generating station. See "Official Notices" to-day.

Blackburn.—February 29th. Stores for the Electricity and Tramways Department. See "Official Notices" February 12th.

Canary Islands.—March 23rd. Tenders are being invited by the Spanish Ministry of Public Works, for the concession for the construction and working of an electric tramway between San Cristobal de la Laguna and Tacoronte (Canaries). Particulars may be obtained from, and tenders are to be sent to, El Ministerio de Obras Publicas, Madrid.

Chili.—June 28th. Tenders are being invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan), by the Municipal Commissioners of that city. Full particulars can be obtained on application to the Chilian Legation, 29, Queen's Gate Terrace, S.W.

Cambuslang.—February 29th. Tenders are invited for engines, dynamos, switchboard, and lamps, main and distributing cables, and other works necessary to provide a complete system of electrical supply within the special lighting district. See "Official Notices" February 12th.

Cape Town. — Arc lamps for the Exhibition. See "Official Notices" to-day.

Ealing.—February 25th. One 750-KW. steam alternator, condenser, &c. See "Official Notices" February 12th.

Edinburgh.—February 22nd. Engine and dynamo of large size. See "Official Notices" January 22nd.

Gainsborough.—March 16th. Telephones and fire alarms for the U.D.C. See "Official Notices" to-day.

Gravesend.—February 25th. Five motors ($\frac{1}{2}$ to 12-B.H.P.). See "Official Notices" February 12th.

Greenock.—February 25th. One 400-KW. steam-driven traction and lighting generator. See "Official Notices" February 12th.

Hammersmith.—February 24th. Meters, service and fuse boxes. See "Official Notices" February 12th.

Hanley.—February 22nd. 500-KW. steam or turbo-alternator, condensing plant, superheaters, &c., for the electricity works. See "Official Notices" January 29th.

Hornsey.—February 29th. Stores and cables for the electricity works. See "Official Notices" February 12th.

Islington.—February 24th. Conduits and mains. See "Official Notices" January 22nd.

Islington.—February 25th. Stores for the Electricity Department. See "Official Notices" February 5th.

Kilmarnock. — February 29th. Pipework, lamps, feeders, switch-pillars, meters, &c., See "Official Notices" February 12th.

Manchester.—March 1st. The Manchester Dock and Warehouse Extension Co. wants tenders for 25 electric hoists and 10 electric fixed cranes. See "Official Notices" January 29th.

May-Oatway Installations.—February 24th. Tenders are invited by the May-Oatway Co. for several installations on their system. See "Official Notices" to-day.

Metropolitan Asylums Board.—March 8th. Tenders are invited for fire alarm and telephone installations at Caterham. See "Official Notices" to-day.

Newport (Mon.).—February 22nd. The Electricity and Tramways Committee invites tenders for 10 electric tramcars. Mr. H. Collings Bishop, engineer.

Port Elizabeth.—February 22nd. The Municipality invites tenders for the supply of certain telephone material. Davis and Soper, 54, St. Mary Axe, London, E.C.

Radcliffe.—February 20th. Station lighting and wiring to motor, testing instruments and accessories. See "Official Notices" February 12th.

Rathmines.—February 20th. Coal, meters, carbons and stores for the Electricity Department See "Official Notices" February 12th.

Russia.—The Russian Post and Telegraph Authorities in St. Petersburg are about to invite tenders for the construction of a telephone line between Odessa and Kiew, at an estimated cost of 500,000 roubles.

St. Annes-on-the-Sea.—February 27th. Steam dynamo. See "Official Notices" February 12th.

Salford.—February 29th. Stores, &c., for the Electricity Department. See "Official Notices" to-day.

Snowdon.—February 29th. $1\frac{3}{4}$ miles of 36 in. diameter steel piping for the Portmadoc and North Wales Co.'s power station. See "Official Notices" February 12th.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" January 15th.

Spain.—February 26th. The Municipal Authorities of Cuenca are inviting tenders until the 26th inst. for the concession for the electric lighting of the town during a period of 15 years. Tenders are to be sent to El Secretario del Ayuntamiento de Cuenca, whence particulars may be obtained.

Spain.—March 21st. Tenders are being invited until March 21st by the Spanish Ministry of Public Works in Madrid for the concession for the construction and working of an electric tramway in the town of Seville. Tenders are to be sent to La Direccion General de Obras Publicas, Madrid, whence particulars may be obtained.

Stourbridge.—February 26th. Engines and dynamos, boiler, booster, crane and battery, for the U.D.C. See "Official Notices" February 12th.

Sunderland.—February 26th. Crane and battery. See "Official Notices" January 29th.

Weymouth.—March 7th. Lighting the Corporation's generating station, and supply of meters. See "Official Notices" to-day.

Wimbledon.—March 18th. Stores for the Electricity Department. See "Official Notices" to-day.

Wrexham.—March 12th. Stores for the Electricity Department. See "Official Notices" to-day.

CLOSED.

Beckenham.—The U.D.C. has accepted the tenders of Messrs. Buchanan & Curwen, Beckenham, Mr. G. Dean, Beckenham, and Messrs. E. Newbald & Co., Sutton, for free wiring.

Cape Town.—We are informed that the contract for the electric lighting and power at the forthcoming Cape Town Industrial Exhibition, 1904-5, has been placed with the Torque Electrical Engineering Co., 20—28, Dalling Road, Hammersmith.

Dunedin (N.Z.).—The British Westinghouse Co. has received an order from the Dunedin (N.Z.) branch of Messrs. Noyes Bros. for a 5,000-volt alternator of the rotating field type, with direct-connected exciter.

London.—The following tenders have been received by the L.C.C. for the reconstruction for electric traction of the cable tramways between Kennington and Streatham:—

W. Griffiths & Co., Ltd.	£86,624
J. G. White & Co., Ltd.	95,005
Dick, Kerr & Co., Ltd.	95,751
Edmund Nuttall & Co., Manchester	97,133
W. Underwood & Bro., Dukinfield	99,221
R. W. Blackwell & Co., Ltd., London	104,605
Pethick Bros., London	110,143
John Mowlem & Co., Ltd.	111,710
Wm. Kennedy, London	113,897
Geo. Law, Kidderminster	128,588

The Highways Committee proposed to accept the tender of W. Griffiths & Co., who undertook to complete the work in three months from March 31st, but the consideration of the question has been postponed for a week.

Lowestoft.—For supplying electrically-driven plant at the pumping station to the T.C.:—

Blake, Knowles & Co.	£907
Reavel & Co.	750
R. W. Blackwell & Co.	1,114
British Westinghouse Co.	730
Hughes & Lancaster	1,057
Ingersoll Sargent Drill Co. (*accepted*)	726

FORTHCOMING EVENTS.

Friday, February 19th.—At 2.30 p.m. Civil and Mechanical Engineers' Society. Visit to the Shallow Tramway under Kingsway.

Saturday, February 20th.—At 2 p.m. Junior Institution of Engineers. Visit to the Colonial Consignment and Distributing Co.'s Frozen Australasian Meat Stores, Lambeth.

At 3 p.m. Royal Institution. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes." (Lecture I.)

At 7.30 p.m. Glasgow Technical College Scientific Society. "Modern Conceptions of Matter," by Mr. Angus MacLean.

At 7.30 p.m. Institution of Electrical Engineers (Students). "The Testing of Alternating Current Machinery," by Mr. R. J. Kaula.

At 2.30 p.m. Institution of Electrical Engineers. Students' visit to the Central Electric Supply Co.'s works, Grove Road, Marylebone.

Wednesday, February 24th.—At 7.30 p.m. Institution of Electrical Engineers. Students' meeting. "Automatic Railway Signalling," by Mr. E. Fisher.

At 8 p.m. Liverpool Engineering Society. Mr. G. Balfour on "Conduit and Surface Contact Tramway Systems."

Thursday, February 25th.—At 8.0 p.m. Institution of Electrical Engineers. Adjourned discussion on "Trans-Atlantic Engineering Schools and Engineering," by Dr. R. M. Walmsley.

At 5 p.m. Royal Institution. Prof. H. L. Callendar on "Electrical Methods of Measuring Temperature." (Lecture I.)

Friday, February 26th.—At 5 p.m. Physical Society. "A New Dilatometer," by Mr. Borniksen; "A Quartz-thread Vertical Force Magnetograph," by Dr. W. Watson; "On Stresses in a Magneto-static Field," by Mr. G. W. Walker; "Some Hints on the Preparation of Diagrams," by Dr. W. Watson.

At 8 p.m. Institution of Civil Engineers (Students). "Boiler-house Design," by Mr. L. G. Crawford.

At 9.0 p.m. Royal Institution. Mr. Alexander Siemens on "New Developments in Electric Railways."

North-East Coast Institution of Engineers and Shipbuilders. Meeting at Newcastle-upon-Tyne.

Northampton Institute. Prize distribution by Lord Kelvin, and Conversazione.

Institution of Electrical Engineers (Manchester). Annual dinner.

Saturday, February 27th.—At 3 p.m. Royal Institution. Lord Rayleigh, F.R.S., on "The Life and Work of Stokes." (Lecture II.)

Association of Engineers-in-Charge. Concert and dance.

NOTES.

The Motor-Omnibus.—The chairman of the London Road Car Co. (Mr. J. H. Moore), answering a question put to him as to whether the company proposed to start motor-omnibuses, said he believed that the omnibus had a greater future before it than any other class of vehicle. They would shortly have one or two motors on the road; the motor would be their trump card, and "when the proper one was found, it would easily beat the tramways running on fixed rails, and with an expensive electrical system. He did not think it would be long before the directors would be able to invite the shareholders to view a perfect motor."

Mr. Alderman Pound gave his hearers some important information respecting motor traction at the meeting of the London General Omnibus Co. He is reported to have said:—"With regard to motors, they were six months nearer their adoption than when he last addressed them." Seeing that he addressed them at the last half-yearly meeting six months ago, the statement is indeed remarkable. What the remark amounted to was, "We are as we were in relation to this matter, gentlemen!"

Municipal and County Club.—At the house dinner of this club held on the 8th inst. at Whitehall Court, Sir Francis J. S. Hopwood, K.C.B., C.M.G., Permanent Secretary of the Board of Trade, was the guest of the evening. The Municipal and County Club, which was founded in February, 1903, now has a membership of close on 500 members.

New Technical Journal.—We are pleased to announce the issue of a new French electrical journal, under the direction of M. J. Blondin, and with a title synonymous with our own—namely, *La Revue Electrique*. The *Revue* will appear twice a month, and will contain special articles, abstracts, accounts of new inventions, a bibliography, and notes bearing on the most recent progress in electrical science. The first number contains articles on the Edison accumulator by L. Juman, and single-phase traction on the Arnold system by the editor, as well as a variety of minor matter. We wish all success to our new contemporary, which hails from the well-known Librarie Gauthier-Villars, Paris.

Was it Satire?—According to the *Sunderland Echo*, "Lord Kelvin, who has done so much to advance the world's knowledge of electricity, dislikes the electric light. When he visited the United States a little while ago with Lady Kelvin they spent a short time of their stay with Mr. and Mrs. George Westinghouse, of Westinghouse brake fame, whose home after dark is a blaze of electricity. The first night they spent there Lady Kelvin rang up a servant to beg that they might 'be accommodated with a couple of tallow dips, as they were unaccustomed to such intense light in the bedroom.'" We have heard stories about wiring in America. Our readers may draw their own conclusions.

Sir R. Tangye's Views on Protection.—Writing to the *Standard* on February 1st, Sir Richard Tangye says:—"There are some aspects of the effects of Protection upon the vital interests of the working classes that cannot be too strongly impressed upon their minds. It has been clearly demonstrated that if we put a stop to the importation of foreign productions we necessarily put a stop to the export of our own, seeing that all foreign trade is based upon an exchange of products. The avowed object of Protection is to destroy the competition of the foreigner in our home markets; or, in other words, to increase the prices charged to the consumer in this country. Now, who ever heard of the demand for manufactured goods being increased by raising their prices? And yet this is precisely what Mr. Chamberlain says will happen if his proposals are accepted. My firm employs more than 2,000 men, and it is quite conceivable that any loss of profit that we might sustain through a shrinkage in trade consequent upon Fiscal changes would be more than compensated by increased prices in the home market. But how would this help the working man? A lessened trade would require fewer men, consequently there would be greater competition for employment, and wages would proportionately fall. Very good for the employer, since he would get as much profit as before on a smaller turnover, with a proportionately reduced responsibility, while for the working man there would be less employment, and lower wages, aggravated by an increased cost in living and clothing. My firm do business in all parts of the world, and, so far from desiring Protection, we believe that its imposition would be disastrous to the best interests of all, but especially to the working classes."

Junior Institution of Engineers' Dinner.—The nineteenth annual dinner of this Institution was held on Saturday last at the Hotel Cecil, the President, Mr. J. Fletcher Moulton, K.C., F.R.S., M.P., being in the chair. Among those present were Lord Balfour of Burleigh, Captain Sir Andrew Noble, Prof. D. S. Capper, Mr. R. Kaye Gray (President Inst. E.E.), Mr. H. T. Eve, Colonel Raban, Messrs. Kenneth Gray (past chairman), S. Cutler, jun. (chairman), Percival Marshall (past chairman), J. H. Pearson, and many other well-known visitors and members.

After the loyal toasts, the President proposed "British Commerce," a subject which his position compelled him to handle very gingerly. Referring to its past history, he pointed out the vast influence exerted by the advent of telegraphs and steam engineering. He had faith in its future, believing that the British nation possessed the two qualities essential to success—enterprise and character—qualities for which the firm of Armstrong, Mitchell & Co. was renowned in the highest degree.

In reply, Sir Andrew Noble said that the future of our Commerce lay in the hands of such as the Junior Institution of Engineers. It was unfortunate that the fiscal question had ever become a party one, as an impartial inquiry was urgently necessary. The rise of steam railways and steam navigation was contemporaneous with Free Trade, and was the real source of the prosperity of the country. James Watt and George Stephenson were our benefactors rather than Richard Cobden, whose predictions that the abolition of the corn laws would not throw land out of cultivation, and that all nations would adopt Free Trade, had been wholly falsified. England stood alone—even her colonies were opposed to her fiscal policy. Twelve thousand British ironworkers were recently thrown out of work, while the imports of foreign steel had enormously increased. Alcohol, for industrial purposes, could be had in Germany at 6d. a gallon—here it cost 11s. Countrymen were forced into the towns, and the physique of the nation deteriorated, through the decline of agriculture.

The toast of "The Bench and the Bar" was introduced by Prof. Capper, and suitably acknowledged by Mr. Eve.

Mr. Kenneth Gray, in proposing "The Senior Institutions," paid a tribute of gratitude to the latter, and appealed to the Committee on Engineering Education to include the hitherto neglected subject of heating and ventilation in the curriculum of the young engineer. In his reply, Mr. R. Kaye Gray commented on the apparent lack of difference between the senior and junior Institutions, and remarked that the Education Committee had adopted two guiding principles—it would avoid excessive standardisation, for individuality was one of the best features which had contributed to the success of British industry; and it would try to ease the way for the future James Watts and George Stephensons. Mr. Gray thought that perhaps the progress in engineering due to these men had been at the root of agricultural depression.

Lord Balfour toasted "The Junior Institution," and compared ancient and modern engineering works with regard to their application to the service of man—to the advantage of modern practice. He added technical skill to the two essential qualities defined by the President, and said that it was the worst possible mistake to suppose that one's education was completed when one left college to commence practical work. Herein lay the utility of such an institution as the subject of the toast. Mr. S. Cutler, jun., replied, referring to the 19 years of success of the Institution, which was now preparing to extend its operations to the provinces, was arranging a visit to Germany, and had raised its entrance fee. Mr. Cutler eulogised the merits of the secretary, Mr. W. T. Dunn, who, he said, had "made" the Institution.

Mr. Percival Marshall proposed the health of "Absent Members," instancing various important works upon which they were engaged, and uttered a warning as to the depressed state of engineering in South Africa. Mr. Pearson toasted "The President," who, in reply, exhorted the members to make the best use of their youth, and the proceedings came to an end with "Auld Lang Syne."

During the evening Miss Maude Smithers gave a pianoforte solo and recitations, Mr. T. E. Gatehouse (hon. member) performed violin solos, and Mr. Kenneth Gray sang, all to the great enjoyment of the audience.

Old Faradians at Dinner.—Old Faradians of Manchester and the neighbourhood dined together at the Midland Hotel, Manchester, on Saturday last with, Mr. C. D. Taite, borough electrical engineer of Salford, in the chair. Mr. Robert Hammond, in replying to the toast of "The Electrical Standardising, Testing and Training Institution," confessed that when he remembered that more than 20 years had passed since he first started the College in Red Lion Square, he realised that he was getting old, a statement which evoked a storm of disapproval. Nevertheless, he added, I feel no evidence of it. Referring to an ambition he had when a boy to plant trees, which he had not found possible to satisfy, he felt that in planting the number of electrical engineers (about 500) who had passed through the Institution in their profession he had achieved that ambition in a more valuable form. The toast of "The Visitors" was responded to by Mr. E. Cowan, chairman of the local section of the Institution of Electrical Engineers. The speeches were commendably brief, as the dinner was followed by a smoking concert. The gathering was a great success, and will be repeated next year. Much credit is due to Mr. J. T. Tiplady, the honorary secretary of the dinner committee, whose efforts were brought to such a happy fruition.

(*Continued on page* 308.)

ELECTRICITY IN THE MAKING OF MUSIC.

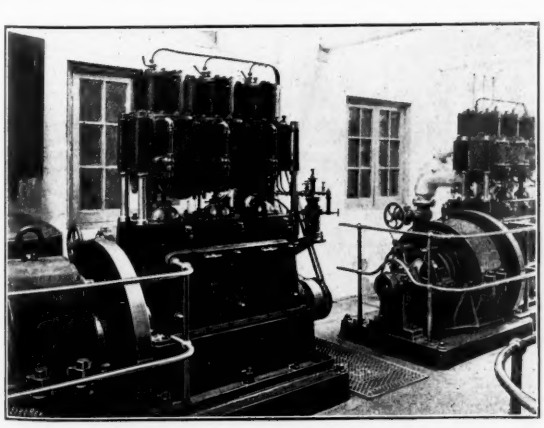
Her ivory hands on the ivory keys,
Strayed in a fitful fantasy,
Like the silver gleam when the poplar trees
Rustle their pale leaves listlessly;
Or the drifting foam of a restless sea
When the waves show their teeth in the flying breeze.

In the *London Magazine* for September, 1903, there appeared a highly interesting and instructive article entitled "The Romance of a Piano." It described the evolution of the most popular, or at all events the most played upon, instrument of the day; its introduction into England; the multifarious processes in its manufacture; the supremacy of the British-made piano, and the classical musical names that will for ever be indelibly associated with it. Some very charming portraits of Mozart, Beethoven, Chopin, Wagner, Liszt and Handel embellished the text; while illustrations of the clavichord, the harpsichord and a modern grand and expensive pianoforte connected the past with the present; and last, but not least, a portrait of John Broadwood, the first English manufacturer of the piano, gave one a fine appreciation of the splendid type of man who originated what is to-day the largest manufactory of these instruments in the Empire.

We are aware that many of our readers are ardent votaries of the Divine Art, others are performers of more than average ability, and we would gladly enlarge upon this part of the subject, but as our main object is to dilate upon the applications of electricity in "The Reality of a Piano," we must deny ourselves the pleasure of going into a dissertation on the immediate predecessors of the instrument, and confine our remarks to what we understand by the pianoforte of to-day, based upon what we saw on the occasion of the Press view of Messrs. John Broadwood & Sons, Ltd., new factory at Old Ford, near Victoria Park, E., on Tuesday, the 2nd inst.

The Buildings, Power House and Electric Crane.

Making the Sounding Board.



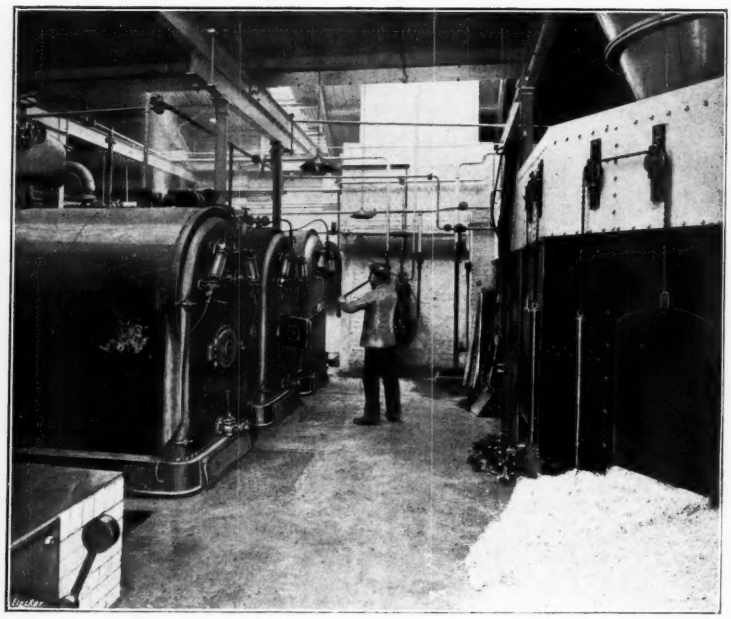
Peache Engine and Crompton-Paxman Dynamo.

It is a curious fact that very few pianists, whether professional or amateur, have any accurate knowledge of the construction of the instrument, so that the performer has rarely any clear notion of the manner in which his music is produced; yet the first principles can be easily understood, and a couple of hours spent in a large piano factory cannot fail to be a source of delight and interest.

Science and Music oftentimes go hand in hand, but whereas the former is held to be hindered in its progress by the many tongues of the various civilized races, and is, therefore, in need of a universal language, Music, as Longfellow has well said, is the universal language of mankind. How well Science is brought to bear, however, on the making of the instrument that may be styled the voice of the musician, the only means whereby unaided he can give complete utterance to his thoughts, the only vehicle for the communication of his musical ideas, that "concord of sweet sounds" in their entirety, we will now endeavour to explain.

The first grand pianoforte, manufactured by John Broadwood in 1770, was soon improved. Broadwoods brought out in 1847 their first "iron grand piano," an invention by which the instrument became partially independent of the wooden bracings below the sounding-board, and was thus enabled to sustain far thicker strings than formerly, the methods of pianoforte construction being thus entirely revolutionised. Chopin's piano, made for him by the Broad-

woods in 1848, contained no less than five heavy parallel bars of iron; and recently they have perfected their famous "steel barless" grand, wherein an elastic, yet enormously powerful, steel frame takes the place of the old-fashioned cast-iron one, all internal bars being omitted, the old



Locomotive Type Boilers.

"gridiron" casting being thus abandoned in favour of a free-toned, open frame.

As the modern pianoforte depends for its durability upon a strong framing of metal, a well-equipped engineering shop is a necessary adjunct to a modern pianoforte factory. One is, however, hardly prepared to find so extensive and so well furnished a machine shop as that in which the various processes of drilling, pinning, and japanning of the metal frames are carried out. The frames are heavy pieces, sometimes weighing as much as 5 cwt., and the distances which have to be traversed between the spot where they are completed and the workshops in which they are required for incorporation in the pianoforte, are very considerable; but the appliances provided carry out the work with ease and rapidity.

Of the three upper floors of the main building, two are devoted to the manufacture of grand, and one to the manufacture of upright, pianofortes. In the grand case-making shop, which is on the first floor, the various parts are put together, and the case having been veneered it is ready to receive the sounding board, which, as in the violin, is a most important part of the instrument. In many ways the sounding board of the pianoforte resembles that of the violin, but it differs in that it has to withstand a stress, not from four light catgut strings, but from a very large number of steel wires under a heavy tension, varying from 18 to 32 tons according to the size of the instrument. The construction of the sounding-board is therefore very strong, and the ample dimensions of the modern pianoforte give scope for an instrument of far greater tone-power than was formerly the case.

The material used for the sounding board is the wood of the well-known spruce fir (*abies excelsa*), the familiar Christmas tree. This is obtained from central and eastern Europe, where it is carefully selected and prepared, it being essential that the timber should be sawn in such a way that the grain of the wood should be exactly as is required. Many experiments have been made with the object of discovering some material that should replace this timber in the manufacture of musical instruments, but nothing has been found to equal spruce fir in resonant qualities, owing to the great strength and elasticity, combined with great lightness, which are its chief characteristics. The quality of a pianoforte depends largely upon the construction of the sounding board and upon the determination of the scaling or the lengths and sizes of the strings or wires.

The sounding board completed, the pianoforte receives the metal frame, which enables it to withstand the great strain which will be put upon it. As we have previously said, Messrs. Broadwood & Sons have recently introduced their already well-known patent steel barless frame, the use of which, while providing all the strength that is necessary, and which was hitherto obtainable only by the employment of rigid iron castings, provides a certain degree of resilience which has a marked effect upon the tone of the pianoforte, giving it a sonority and a beauty of tone-quality not hitherto attainable.

The pianoforte now receives the strings, which are the source of its sound. Steel of the very finest quality, drawn in the most careful and skilful manner, is the only material fit for the purpose, and it comes from Germany! We understand, however, that a Birmingham firm has recently gone into the matter of music wire-drawing, and are producing a wire which seems likely to compete successfully with the foreign makes. We hope to hear of its success, but the fine wires evidently demand great care and skill in manufacture. The pianoforte now passes to the "finishers," for the fitting of the "action," the technical name for the ivory keys, the hammers, and their connecting mechanism. All the work relating to the action of a high-class pianoforte is necessarily of excellent quality; nothing but the best materials and the best workmanship can possibly produce a result which will not only please the pianist when the instrument is new, but which will also stand the test of time. Nowhere is this so

The Metal Workers' Shop

evident as in the action, an inspection of which reveals an immense number of small moving parts, clothed, padded, and lined with cloth felt and leather, and furnished with all kinds of little springs and wires.

Polishing plays an important part in the manufacture, and the final processes through which the now completed pianoforte passes, are regulating and tuning, which leave the instrument ready for delivery to the show rooms. The employés in this department are men of tried skill and special aptitude, and their work is the result of long and careful training.

There are few, if any, manufactures in which there are so many various trades, all necessary to the production of the finished article, as those combined in the making of a pianoforte, and it is difficult to realise, except by actual inspection, through how many hands the instrument passes from the commencement until its completion.

Messrs. Broadwood have provided very thoroughly for the comfort and well-being of their workers, and a description of the factory would be incomplete without a reference to the men who are constantly engaged in the production of the Broadwood pianoforte. It is upon the organisation and training of the workers themselves that the quality of the product chiefly depends. Messrs. Broadwood fully recognise this, and the 500 men and youths employed by them are so trained and organised that everyone becomes a specialist in his particular branch, while each group of mechanics is directed and supervised by a foreman who is a strict disciplinarian as well as a pastmaster in his own art. It is only by the harmonious co-operation of these workers of many handicrafts that Messrs. Broadwood are enabled to produce the best possible result, and to successfully maintain that high place in the public estimation which has been theirs for so many years.

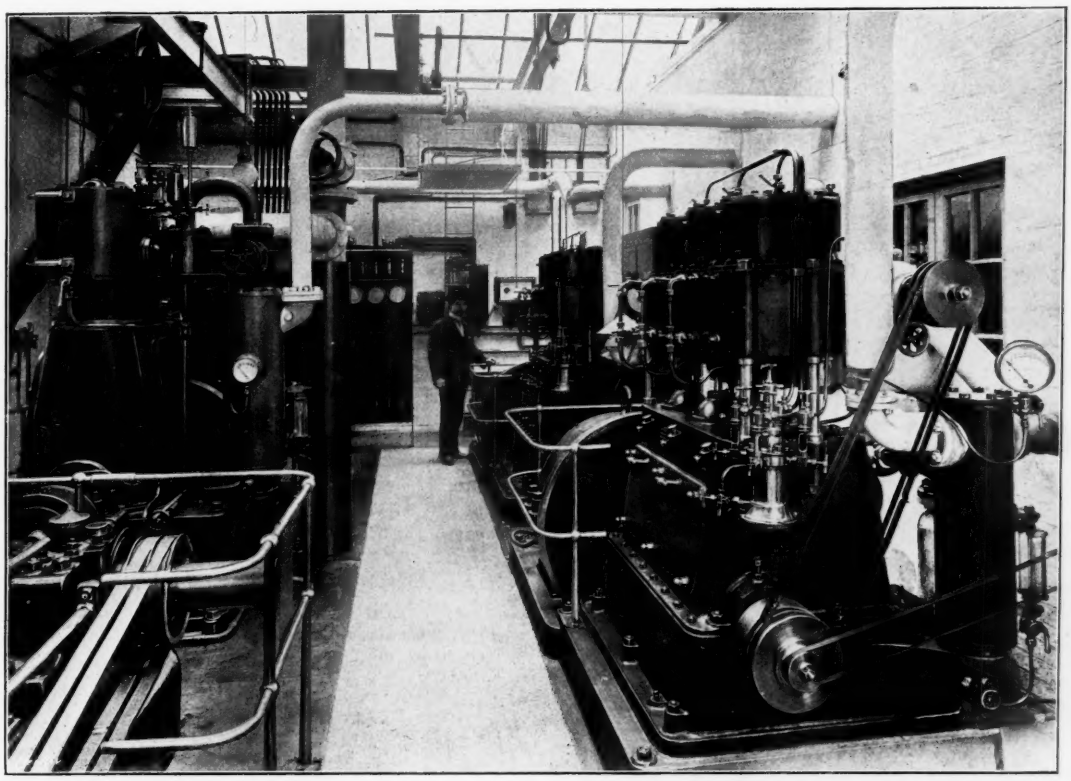
Covering the whole plot of ground within a boundary formed by Stour Road, Smeed Road and Beach Road, not far from Old Ford Station, and another plot on the Hackney Canal connected by a private tramway, these works have been designed to meet the requirements of the great business established more than a century and a half ago.

Every approved modern machine tool or appliance tending to rapidity and improvement in the product has been adopted, and it is electrically lighted throughout by about a thousand incandescent lamps. Electric power transmission is largely used in the combination system adopted of driving the varied kinds of machinery, partly by light high-speed shafting and partly in groups or singly by electric motors. Five electric power lifts and an electric tramway are also employed.

Various as are the processes to be carried out, beginning with the rough materials at the far end of the great factory to the finished pianoforte in the store at the other, no part of the path is traversed a second time.

As it comes from the machines the wood is stacked on special trucks, and on these passes to a traverser truck at one end of the adjoining air-drying house, where it remains from a few weeks to two months in the five drying chambers. When completely treated the trucks are delivered at the other end of the chambers to a second traverser truck, and by it delivered to a three-ton electric lift, with a 15-H.P. motor, which lifts it to one or other of two floors above the drying chambers. On these floors are rails on which the trucks run for delivery of the wood for storage.

For these upper floors the wood as required is taken to the next building, in which is a very large collection of modern machinery. Most of this is of British make, but some special machines are from America, while in other parts of the factory are some German and some French machines.



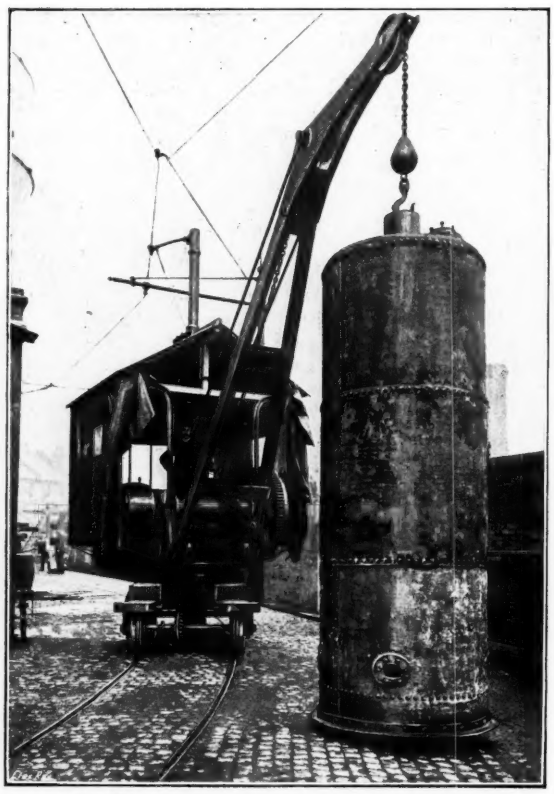
The Power House.

The machinery in this wood-working machine shop includes numerous planing, thicknessing and surfacing machines, with cutters from 12 in. wide to 48 in., the largest machine in the country; machines for planing four sides at one operation; tenoning machines, mortising machine, circular and hand saws, moulding machines for moulding from ½ in. up to sizes which cut to a depth of 3 in. and width of 9 in. for shaping the falls or keyboard covers, large and small sand-papering machines, vertical spindle moulding machines, vertical spindle sand-papering machines and numerous other special machines.

The whole of the chips, shavings and sawdust from the machines in both this large mill and the rough saw mill are carried off by an extensive system of pneumatic conveyors to cyclones over the sawdust chamber in the boiler house to be burned under a specially-arranged furnace of a Babcock and Wilcox boiler.

Parallel with the large mill is a large metal-working shop,

where the steel and the iron frames of the grand and upright pianofortes are prepared. This shop contains a large number of special drilling machines, planing machines,



Electric Travelling Jib Crane and Tractor.

radial and other drills and tapping machines, lathes and hinge-making machines. This shop is provided with complete lines of overhead travelling carriers, which command the whole of the drilling machines and the tramway, and reduce the cost of lifting and carrying the frames to a minimum.

The products of the metal shop pass on to the japanning and gilding shops, and thence to the large four-storey building in which are the case-making and finishing shops. Tram-rails are laid throughout the ground floor.

The products of the wood-working machinery departments also pass on a continuous process path to the various departments in the main building. Here again is a large quantity of machinery driven by electric motors, so distributed as to avoid the loss of time which commonly occurs where ample appliances are not provided for a continuous-process system. Three of these floors are provided with tramways and with overhead traveller rails and appliances for the economical handling of the work. The overhead travellers lead to and from the two 1½ ton lifts worked respectively by 10 and 12 H.P. electric motors serving every floor.

In this building some 500 hands are employed, and it need hardly be said that a great quantity of saw dust and shavings is produced every day. To facilitate the removal of this, every floor is provided with communication to a large shoot from which the rubbish is carried away by another extensive system of pneumatic conveyers to the boiler house.

At the north-eastern end of the works are situated the boiler and engine and dynamo houses.

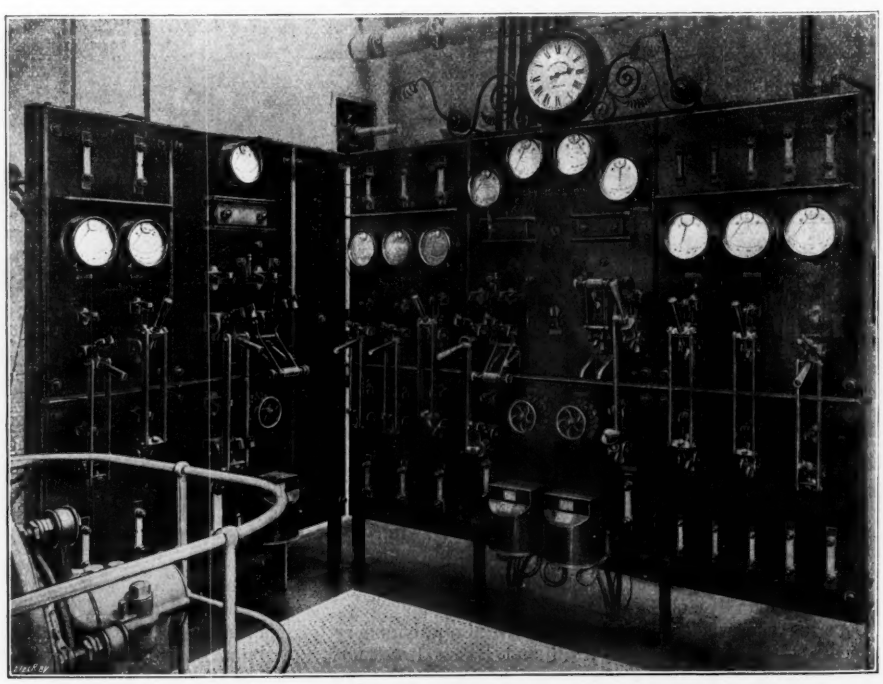
The boiler house contains four boilers, three of the locomotive type by Messrs. Davey, Paxman & Co., giving steam for about 320 H.P., and one Babcock & Wilcox boiler giving about 100 H.P., all working at a pressure of 120 lbs. per sq. in. The feed-water for these is heated by a large Boby-Chevalet detartariser, and a complete system of feed pumps with duplicate connections to all the boilers, feed heater, separator and elevated feed-water tank is provided.

In the engine house are four engines, one a compound horizontal engine by Davey, Paxman & Co., capable of developing about 100 I.H.P., for driving the large mill and the metal-working shop; two sets of combined Crompton-Paxman compound-wound dynamos with Peache high-speed engines for nominally 40 KW., but capable of large overload, each engine being capable of about 80 I.H.P.; and arranged for working in parallel with both or either of these 40-KW. sets is an 80-KW. Crompton-Belliss compound-wound machine capable of heavy overload, the engine giving easily 120 H.P.

These electric generators supply the whole of the incandescent lamp and the power circuits, the latter alone aggregating 160 H.P. effective, so that, in the winter months, the large set and one small set is always required. The switchboard is by Messrs. Crompton & Co., and Messrs. Ward Bros. have done the whole of the wiring and cable work.

Every work-bench has one and many of them have two lamps, mostly of 32 C.P. And many are provided with wall plugs for electrically-heated glue pots.

By generating their own current, Messrs. Broadwood and Sons have made a great saving, as compared with other methods of obtaining their lighting current, or lighting by gas, and great convenience also results in having the electric power transmission facilities entirely under their own control. The rough saw-mill is driven by two motors, one of 26 H.P. and the other of 20 H.P.

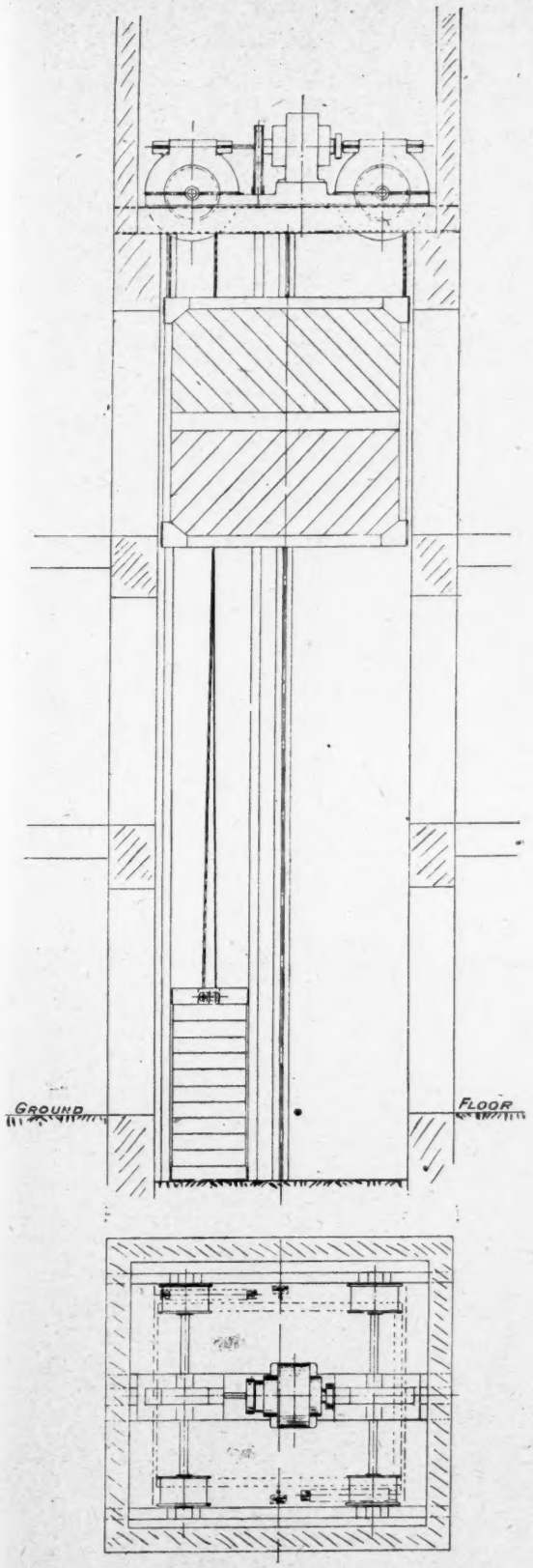


Crompton Switchboard.

The electric travelling jib crane and tractor on the electric tramway has a 15 H.P. motor, and in different parts of the factory there are altogether 19 motors, varying from 2½ to

26 H.P.; nearly all of them entirely closed motors and all running on 230-volt circuits.

The pneumatic dust and shavings conveyor system includes probably the longest suction and delivery yet attempted with success with one large fan exhausting two



3-Ton Electric Lift.

long suction trunks, connected to a large number of machines, and delivering by a single long trunk into one large cyclone receiver, which is at the same time also receiving from another trunk from another direction supplied by a second fan. Two cyclones are employed, that above-mentioned, and one separately used for the shavings and rubbish from the four-storey building, the trunk delivering to it over a distance of more than 200 ft. This pneumatic conveyor plant has been supplied by the Sturtevant Co., under the specifications and superintendence of Mr. W. Worby Beaumont, M.Inst.C.E., consulting engineer to Messrs. John Broadwood and Sons, and under whom the whole of the engineering work of this factory and the former establishment at Westminster has been carried out.

It will be seen that the several buildings forming the main workshops, the saw mills, drying house and metal shops are very different fire risks, and many of the arrangements adopted, as, for instance, the belt chamber in the metal shop, have been dictated by this consideration.

The electric power and lighting supply is interesting from several points of view. It is an example of works which would provide good consumers to a central supply station. The local conditions, however, are such that it would require an exceedingly low quotation before an electric supply undertaking could gain a footing. To review these conditions briefly a central supply station has the advantage that its plant is laid down on a larger scale, and hence should be cheaper in first cost per unit of plant than for a private supply. Also, the larger plant is more economical in steam consumption and hence in fuel. A third point claimed is that the central supply to a large number of consumers in different trades obtains a higher load factor in consequence.

As against these three real advantages, there is the fact that the cost of distribution has to be borne. While the loss in the mains may not be a serious matter, the capital charges on account of these mains seriously affect the price at which a supply can profitably be given.

The private plant is necessarily on a smaller scale, and if arranged with due regard to spares to meet emergencies, is bound to consist of two or three generating units of comparatively small size. The cost of these, as compared with their output, is of course high, but the whole capital charge per kilowatt on a private plant for factory work, will be found to be very much less than for a central station, with mains included. On the load factor question much depends on the factory under consideration.

In the case now before us the power load is practically constant within certain limits throughout the working day. Also, owing to the proportion between the power and lighting loads, the lighting peak in the load curve is not so abnormal as in London supply stations, and it is flat.

The features in connection with Messrs. Broadwood's system, which are specially favourable to the private supply are the following:—

(*a*) The firm requires steam in large quantities for other purposes than power, such as the wood-drying department, the wood-bending by steam and the supply of steam to numerous hot plates and glue pots. Hence, even if the firm were to take supply from the public mains, steam boilers would have to be installed for these purposes and kept at work. With the present plant exhaust steam is largely used for heating.

(*b*) The large amount of wood required in piano manufacturing has to be specially selected, and this involves a large percentage of waste. The proportion of the wood entering the works which is thus discarded in one form or another, ranges from 30 to 50 per cent. The Babcock and Wilcox boiler of 100 H.P., to which reference has already been made, is entirely fired by this waste, which reduces the cost of fuel.

(*c*) The labour charges which can be fairly proportioned to the electric plant are low, because of the fact that the steam plant would be working in any case, and the additional engines have not necessitated any further staff.

The actual cost of the unit generated in a private plant of this kind is exceedingly difficult to take out. In the first place, the boilers supply steam into a common range of pipe from which the electric plant and the engine driving the metal shop and wood-working shop are connected. It is hence no easy task to divide out fuel charges and also the labour in the boiler house and engine room. An interesting comparison was, however, made between the cost of fuel and light in the new factory and in Messrs. Broadwood & Co.'s old works in Horseferry Road, Westminster These older works were driven by the same steam engine as is

now in position at Old Ford; they were steam-heated and lighted by gas. There were also two electric motors supplied from the main of the Westminster Electric Supply Co. The cost for a winter month of fuel, gas and electricity at these works was then compared with the similar cost of fuel and gas at the new works at Old Ford. The comparison showed a clear saving of considerably over 25 per cent. in spite of the fact that the new works are larger. They thus require more heating, a larger number of lights and also have much more plant requiring mechanical power. The comparative figures for the years 1901 and 1903 are now being taken out, and the results confirm the above saving. The units generated in 1903 amount to 76,002.

The advantages of electrical driving in this factory are most marked, although only applied to those parts which are at a considerable distance from the engine room. Nineteen electric motors have been put in to drive machinery placed advantageously along the route of the materials from the timber store to the department round the offices into which the finished pianos are received. In this way the progress of the material is, as we have before said, continuous, and there is no need to bring back the pianos in a half-finished state into shops where all the power-driven machinery would otherwise have had to be grouped.

There are five electric lifts in the factory, of which the largest is placed in the timber-drying department. The electric lift illustrated herewith provides a connection between the various floors of this department. It is capable of taking a 3-ton load, but is overbalanced by the counter-weight, so that 1½ tons is the maximum out of balance load to be driven. The lift was supplied by Messrs. J. G. Childs and Co. The whole of the machinery is placed over the lift well, and consists of two drum shafts, each having two turned grooved drums; these shafts are operated by right and left-handed worms and wheels connected directly on to the motor-shaft. They are so arranged that the thrust on each worm shall be equal to and opposed to that of the other. The worm wheels are of cast-iron, with phosphor-bronze rims, and the worms are of mild steel.

The gearing is enclosed in a cast-iron case, which also serves as an oil bath. The motor is of the slow-speed compound-wound type, of 12 B.H.P. The usual safety devices to prevent over-winding and to support the cage in the event of the ropes breaking are provided. The 1½-ton lift by the same maker in the main factory is worked with a single worm-gear, and in this case the thrust of the worm is taken on a ball thrust bearing. The other three lifts are all of the Messrs. Pickering's make.

A system of electric clocks installed by the Synchronome Co. ensures uniform time throughout the factory. These clocks, of which there are about 20, are driven by electric impulses sent over the circuit from a single master-clock. The four Dey time-recorders in the works entrance are also electrically driven from the same circuit. The works are provided with complete telephone communications between the various departments which is necessary in view of the area covered. The local exchange is placed in the general office, and to it 25 telephones are connected. In the manager's offices plug boards enable rapid connection to be made to any department without the delay caused by going through switching operations at the exchange board. For this Messrs. Ward Bros. were also the contractors.

All the electrical work has been carried out to the specifications of Mr. W. Worby Beaumont and Mr. R. W. Weekes. To these gentlemen, and to Mr. George Rose, the director and technical manager of the great English firm of pianoforte makers, we gratefully acknowledge our indebtedness for every assistance and courteous attention in the preparation of this article.

Finally, we may add that to devise, arrange and carry out completely the system in which no part of the path should be traversed a second time, has been the most difficult part of the work, and is due to Mr. Rose, whose great experience has throughout greatly lightened the task set before the consulting engineers.

Wednesbury.—The T.C. has appointed Mr. Warden Stevens as engineer to its electrical undertaking for the ensuing 18 months at a salary of 75 guineas per annum.

NOTES.

(*Continued from page* 302.)

The Electrical Engineers' Ball.—An addition to the gaiety of nations might have been witnessed at the Hotel Cecil on Monday evening last, when the first ball invented, arranged and privately produced by a few members of the electrical engineering fraternity was set rolling; at first quietly and sedately, but at a later stage more vivacity was exhibited. For a considerable time past a social event of the kind had more than once been suggested, but until December last the suggestion never took any definite shape. Then, however, a few enthusiastic devotees of that series of rhythmic bodily movements and steps, taken either alone or with another or others, through the concerted movements of a certain figure, the time of which is usually marked by music, foregathered with some gentlemen who expressed their willingness to see the thing through, the result being the formation of an Electrical Engineers' Ball Committee of about 35 to 40 well-known names.

From the first, the success of the venture seemed assured, and the faith of those who staked their reputation on it was amply justified, for the number of tickets given up on the evening in question fell just five short of 300.

The Grand Hall of the Hotel Cecil from 10 o'clock till about 3.30 presented a most animated appearance, and the dance programme, which contained no less than 20 items, with several "extras" thrown in, must have satisfied the most exacting votary of Terpsichore. The music was supplied by Ashton's Blue Austrian Band, comprising eight or nine capable instrumentalists, conducted by Herr Kandt, and upon whose performances many favourable comments were passed.

We remember reading in J. Jefferson (*Autobiography*) that "Master and Miss Jefferson were to 'execute a fairy dance.' Now, as our terpsichorean education had been rather limited, it is quite likely that the execution was complete." That is just how we feel over Monday night, and we dare not venture upon a more exhaustive criticism. However, if one may judge from the remarks that were overheard, the giddy throng voted the "hop" a complete success, and there is little doubt that the Electrical Engineers' Ball has come to stay as a hardy annual.

The supper, held in the Victoria Hall, was of the most choice and elegant description, and did credit to the reputation of the great hotel which gave us of its best.

The members of the Committee, who all acted as good and faithful stewards, left nothing undone to achieve a popular success, and they must feel a sense of gratification at the result of their efforts.

Naturally, the London members formed the majority of those present, but a goodly contingent from the North put in an appearance, and the soft, musical language of the United States was heard from afar in pleasant contrast to the harsher dialect of Scotia!

De Forest's Improvements in Wireless Telegraphy.—Dr. Lee De Forest has patented some new devices in wireless telegraphy which are described in the *Western Electrician*. In one he does not as usual connect the air-wire direct to earth through the spark gap at its charging and discharging apparatus, but through a horizontal insulated wire connected to its base. The vertical air-wire is preferably one-quarter of a wave-length in height, and the horizontal wire one-half of a wave-length. The horizontal wire is led from the vertical wire in a particular direction at any convenient height above the ground, and is earthed at its outer end either directly or through a spark gap. The object of this device is to concentrate the lines of force set up in the vertical air-wire by the surgings or oscillations, into the plane of the two wires. This plane, in fact, determines the plane or direction of propagation of the energy radiated, and has thus a directive and concentrative effect on the waves, such as Prof. Artom claims to get by circularly polarising the waves, as explained in a recent note. This is owing to the fact that before the spark occurs between the balls of the spark gap separating the base of the vertical air-wire from the inner end of the horizontal wire, these wires are charged oppositely, and hence the lines of force joining their two charges lie chiefly in the plane determined by the wires. When the spark occurs the surgings set up in the two wires find earth through the secondary spark-gap, at the outer end of the horizontal wire. The resulting wave of energy is plane polarised, having its direction of propagation in the direction of the horizontal wire. This direction of propagation once obtained is preserved by the waves, except in so far as diffusion or spreading out affects it as the waves travel onwards. The coherer or other detector of the receiving station should be so placed that a maximun of positive potential and a maximum of negative potential should occur simultaneously at its two terminals. This is not obtained by the ordinary plan of joining the detector between a single air-wire and earth, for in this case one terminal of it as at zero potential, but by means of two air-wires so situated that the detector is connected between a loop or ventral segment of maximum positive potential in one wire, and a ventral segment of maximum negative potential in the other wire. Another device of De Forest is to surround the radiating air-wire with a series of vertical conductors disposed in a curve, preferably a parabola, with the air-wire in its focus. These conductors are intended to act as reflectors or concentrators of the radiations, and they are connected to earth directly, or through a horizontal conductor running in the direction the signals are to take, and a spark gap. Another spark gap is at the base of the radiating air-wire or antenna, which may be charged by any suitable apparatus. Each of the reflecting conductors is connected at its base with the antenna by means of a wire, and also with the conductor running horizontally in the direction

the signals are to take, and earthed through a spark gap. The earths of these horizontal conductors should be removed from the antenna by a multiple of a quarter wave length, preferably a half wave length. The reflecting air wires should be at such a distance from the radiating or main antenna that the waves radiating from them shall be in step or phase with that part of the wave from the main antenna which is travelling in the same direction. To this end the length of the conductors joining each of the reflecting or secondary antenna with the main antenna, added to the length of the conductors connected to the latter, should be equal to half a wave length more than the length of the conductor which is connected with the main antenna. As it would, in most cases, be undesirable to separate the reflecting conductors from the main antenna so far, the same result is got by introducing lagging or retarding devices in the conductors connecting the base of the antenna with the reflectors.

Contraband of War.—The naval war between Russia and Japan naturally turns our thoughts to the question whether and how far the commercial relationship of this country to the belligerent States is likely to be affected. So far as peaceful commerce is concerned this will probably continue as usual, at the same time English manufacturers must needs consider whether the commodities which they are forwarding to Japanese or Russian ports are likely to be intercepted and detained as contraband of war. It is obvious to everyone—even to those who have never had to consider questions of international law—that the muniments of war must be not be supplied to either belligerent by the citizens of any neutral State. As it would obviously be beyond the power of the neutral Government to restrain its subjects from infringing this rule, a rude method of enforcing it is prescribed by international law, the rules of which provide that any ship suspected of having contraband of war on board may be held up, and that, if no satisfactory statement is made as to the cargo which she carries she may be searched. But, it may be asked, of what interest is all this to the electrical world? The answer is supplied when we consider what is to be included in the term contraband of war. Owing to the fact that modern naval warfare between first-class Powers is a rare occurrence, the definition of what is contraband has not been properly kept up to date. A definition which was given in the "Admiralty Manual," is wholly inapplicable to naval warfare in the 20th century. That definition of contraband included only the muniments of war strictly so-called, and it referred to a number of other articles which might, if specially consigned to the enemy, be deemed contraband. At the present day, however, the list of articles provisionally contraband will be considerably extended, and extended along lines which closely affect the interests of electrical engineers. The dynamo, the motor, the search light have all become part and parcel of the essential machinery of a modern battleship, and will probably be required to be kept at the naval base of a belligerent power in time of war. It has, of course, not been decided that such things are contraband, but we firmly believe that the first opportunity would be taken to decide the point. In these circumstances it will be well for every manufacturer who is consigning machinery of this class to Russian or Japanese ports in Far Eastern waters to have a care that they are not consigned directly to the Government of either country, for if that course is adopted, and the ship is stopped by a warship of a belligerent, it is unlikely that the goods will ever reach their destination.

Electricity in the Factory.—The article which we publish to-day, commencing on page 303, should be of more than passing interest to many; not merely to those who are concerned with the piano, but to those who are interested in arranging and operating factories, and in applying the services of Ampére, pushed by Volta, and driven by Watt.

Personal.—On February 6th the officials and workmen of the Corlett Electrical Engineering Co., Ltd., presented Mr. James Walsh, with a handsome travelling bag. Mr. Walsh, who has been in the employment of the above firm for the last 14 years or so, and was the firm's oldest workman, has been appointed to take charge of an electrical installation in Russia.

At the Plough Hotel, Chelmsford, on Saturday evening, Mr. Andrew Gray, the chief of the Allied Marconi Wireless Telegraph Companies' technical staff, was entertained to dinner and presented with a wedding gift by the members of the staff. The gift consisted of an oak chest containing silver plate.

As there has been a rumour current in some electrical circles that Sir William H. Preece is seriously ill, it gives us very great pleasure to be able to state on the best authority that the report is entirely devoid of foundation. Indeed, he has already benefitted wonderfully from the change in Egypt, and is expected back home and to his duties about the middle of April.

The London County Council has increased the salary of Mr. J. Welling, permanent way engineer, from £400 to £450 per annum; Mr. E. L. Pope, electric mains engineer, from £350 to £400; Mr. H. Vorley, accountant, from £300 to £350; and Mr. C. R. Johnson, assistant traffic manager, from £220 to £235 per annum.

Mr. George Stevenson has been the recipient of the Oxford edition of Shakespeare's works on the occasion of his leaving Messrs. Mavor & Coulson, Ltd., Glasgow, to take up the position of electrical engineer to the Carron Co. engineering department.

Mr. P. Gutteridge, who has been appointed chief clerk of the Gloucester Corporation Tramways, was last week presented by the staff of the Mid-Yorkshire Tramways, at Shipley, with a handsome chiming timepiece. Mr. Gutteridge was previously accountant for the Mid-Yorkshire Tramways.

Mr. J. Lister, late general manager of the Lister Electrical Manufacturing Co., has resigned his position with that firm to join Messrs. Veritys, Ltd., as manager of their motor and machinery department. This department, we understand, is being considerably extended, and plant is being added to manufacture motors and dynamos in greater quantities.

Standard Productions.—The complaint of a Canadian that he could not secure any attention to his special wants from British manufacturers, and that Americans would be willing to supply just what he wanted, comes as a very fitting wind-up to years of contradictory assertions. British Consuls abroad have, it is true, often complained that British manufacturers kept on with old patterns long after there was a large demand for new patterns; but this is a different matter from our published complaint of a Canadian.

Apart from the Consular reports, we have heard almost *ad nauseam* that the British manufacturer was far too much occupied in making everything and anything to expect to make a profit. If asked why he did not make to stock, so as better to be able to supply goods promptly, he referred you to the unpractical ignorance of some of the Westminster engineers, who could not even allow a locomotive brake hand-wheel to be made of the same pattern as that of some other locomotive, but must have every detail freshly drawn by some possibly new pupil in his office, and therefore the cheap building of an English locomotive became an impossibility. Americans, we were told, manufactured to stock in large numbers at a time. Anything, from a lady's hat-pin to a steam crane, was to be found in one or other works docketed and labelled ready to hand down to the customer, on the take it or leave it principle. But as to altering in the slightest detail any of his productions, such a thing was never dreamed off. The American production was perfect of its kind—which we may admit without inquiring too curiously as to the intrinsic value and quality of the kind—and anyone who had the impudence or "gall" to hint at requirements other than those embodied in the best of the kind, was promptly shown the door, with the intimation that his custom could very well be dispensed with, and that it did not pay to make variants from standard patterns. This and much like it was thrust upon us as a doctrine which until we followed it would make the United States of America and the genius of her sons everlastingly transcend anything and everything that ever could be accomplished by the sons of an effete and worn-out system, such as was followed by the British manufacturer who never made half-a-dozen things alike, and went on his knees in joy if a customer planted all the things he did make, and insisted on an entirely new product of which at most he would order, perhaps, two, and expect to get them for the American price.

Now comes over our Canadian friend, who tells us that he finds British manufacturers all too busy or too something else to pay the slightest attention to his request for something not in the right line of standard production. This rouses him to speech, or, rather, to writing, and he holds up for our admiration the American forsooth, whose multitudinous virtues, long held up as a bright and shining light for the backward Britisher have been faithfully followed, until the Britisher is so hung on standard lines that he cannot attend to specials which don't pay, and so drives Canadian to seek at American hands what he cannot obtain here. Has the American changed his methods, and is he also numbered amongst the prophets? Why do our vices suddenly become virtues, and why do our virtues take on the form and semblance of evil? Is it not that, though our faults are many, they are not so bad after all, but that our virtues are even denied us?

It is fashionable to sneer at the ways of the British manufacturer, no matter what he does or does not do. It is wrong, anyhow. The foreigner keeps the game up, and has done so to his own emolument, but there are many users of machinery in various parts of the world who regret the day they were persuaded to buy some inferior, foreign-made flimsiness in place of the customary British goods that had served them so well heretofore. Let us not be misunderstood. We do not consider British manufacturers to be angels of light. We know their faults, but we do realise that nothing they do will be allowed to have aught of goodness in it, and that a Canadian may well inquire if, judging by the complaints of the past, he has not practically admitted that manufacturers here have now taken up with standard productions, and are not to be blamed if they do not see the profit in a casual order for experimental goods in which there is perhaps only a speculative chance of further orders.

Burnley's New Refuse Destructor.—Burnley, said to be the smirkiest town in Lancashire, has just inaugurated its third refuse destructor. It was one of the first large towns to attempt the disposal of refuse by burning, having erected a "Beehive" destructor as far back as 1884—just 20 years ago. This was not an unqualified success, and 10 years later a Beaman & Deas destructor was erected. The new one just erected is of the Meldrum "Simplex." The old "Beehive" destructor had a capacity of 15 cwt. per hour, and in 1890 the cost of destruction was over 4s. per load. The new Meldrum destructor is capable of dealing with about 2½ tons per hour, and the record of an ordinary week's working gives the following figures:—The weight of refuse burned is 209 tons, or an average of 5,202 lbs. per hour. The water evaporated to steam at 130 lbs. pressure per sq. in. was 803,000 lbs., which works out to 1·71 lb. of water per pound of refuse, or 2 lbs. from and at 212° F. This is a remarkably good record. The cost of labour averages 10·62d. per ton of refuse destroyed. The steam, which is generated in a 30 ft. × 8 ft. Lancashire boiler, is used in the electricity works, and a guarantee has been given to the Electricity Committee that at least 600 gallons per hour shall be passed daily between noon and midnight. As much as 15,000 lbs. of steam has been delivered in one hour to the electricity works, and the

average of 12,000 lbs. per hour is easily maintained at an average pressure of 150 lbs. per sq. in. Reckoning 5 tons refuse as equal to 1 ton of coal at 10s., it is estimated that a saving in coal equal to £3 10s. a day will be made, or nearly £1,300 a year. This is not, of course, all clear profit, but it must represent a considerable saving to the Council.

The Royal Society.—The papers down for reading yesterday were: "Theory of Amphoteric Electrolytes," by Prof. J. Walker, F.R.S., and "Atmospherical Radioactivity in High Latitudes," by G. C. Simpson, communicated by Prof. A. Schuster, F.R.S.

Rugby Engineering Society.—Mr. J. T. Irwin was down to read a paper on "The Electric Transmission of Power in Workshops" on 18th inst.

Electric Coal-Cutting Machine Fatality.—Mr. John Kelso, manager of the Forniegair Colliery, near Hamilton, N.B., was fatally injured last week by the electric coal-cutting machine used in the pit. The machine was not working freely, and deceased reached over to remove a projecting piece of coal when his left arm was caught by the revolving iron picks of the cutter, lacerating it from the wrist upwards and almost tearing it out at the shoulder. He was removed to Glasgow Royal Infirmary, where he died the following day.

Found at the Electrical Engineers' Ball.—A bracelet was found on the occasion of the Electrical Engineers' Ball last Monday, and the owner, by giving name, address, and description of the article, can obtain it by communicating with Mr. H. Alabaster, one of the joint secretaries.

Yorkshire College Engineering Society.—At a recent meeting of this society at Leeds, Mr. T. Harding Churton dealt with the subject of "Electric Motors, and the Driving of Machinery."

Appointments Vacant.—The Council of the Institution of Electrical Engineers is prepared to receive applications for the appointment of secretary (£500). A resident engineer is wanted by the Wakefield and District Light Railways Co.

Lecture.—Before the Bradford Engineering Society last week, Mr. E. Preece read a paper on "The Progress of the Electric Industry."

Electric Printing Machinery.—The Prince and Princess of Wales were to visit the new offices of the *Graphic*, in Tallis Street, Victoria Embankment, on Thursday afternoon, to set the entire new machinery in motion by means of an electrical lever.

Wolverhampton Tramways.—The *Daily Telegraph* says that a flock of sheep was passing along Tettenhall Road, Wolverhampton, on Wednesday morning, when one of the animals put its foot on a stud of the new surface-contact system of tramways, and was electrocuted. A dog was also killed, and a pony was thrown down.

Not Mice-Proof.—Messrs. Owen Lucas & Pyke, of 39, Victoria Street, S.W., have sent us some pieces of underground cable which were taken out of an installation which they were recently testing for a client in the country. The specimens—which are of unarmoured cable—have been gnawed through both lead covering and insulation, laying the wires bare. The gnawing has apparently been done by hungry mice (was it at a church?) who seemed to have found in lead and rubber a very appetising dish; what happened to them is not told. The cable, in this case, should, of course, have been armoured, but the cause of the breakdown is sufficiently unusual to be placed on record.

THE CENTRAL STATION ENGINEER.

On Tuesday evening last week the official staff of the Paisley Electricity Department met in a social capacity to honour one of their number (Mr. POOLE) who has taken up a position with Messrs. W. T. Glover & Co., Ltd., of Manchester, this firm being the contractors for laying the cables for the new tramways. During the evening Mr. Parkinson, the chief engineer, in the name of those present, presented Mr. Poole with a handsome travelling bag and useful pocket diary.

Last week the employés in the Warrington Tramways and Electrical Departments made a present to Mr. W. H. GRIMSDALE, who will shortly vacate his position as chief electrical engineer to the Corporation to enable him to return to the office of Messrs. Preece and Cardew, electrical engineers, London, for the purpose of carrying out a large Government contract at Portsmouth. Mr. Mathias (the new chief) made the presentation, which consisted of a pair of Ross's prismatic binoculars and an illuminated address.

Salford T.C. has granted the following increases of salary in the Electricity Department:—Mr. J. COLLINGE, mechanical engineer, from £150 to £175 per annum; Mr. H. DAVIDSON, engineer-in-charge, from £150 to £130; Mr. H. M. CROSSFIELD, chief clerk, from £150 to £160.

Mr. G. E. CLARKE, of Sheffield, has been appointed borough surveyor and electrical engineer at Boston at £300.

Ilford U.D.C. has increased the salary of Mr. ALLEN, mains superintendent, from £150 to £165 per annum.

The Monmouth T.C. last week rejected a Committee's recommendation that Mr. A. W. BLAKE, the electrical engineer, be appointed borough surveyor and inspector of nuisances as well on a three years' engagement at £230. Mr. Blake will remain as electrical engineer for a time with an increase on his former salary.

The following appointments have been made at West Ham electricity works:—Mr. R. W. KEMBLE, of Bournemouth, to be shift engineer, and Mr. T. C. HUNT, of West Ham, to be mains assistant.

Mr. WM. BURR, station superintendent at the Reading Electricity Works, has been appointed chief assistant electrical engineer at the Croydon Electricity Works, out of 154 applicants for the post.

The Hammersmith Board of Guardians has decided to appoint an electrician as engineer-in-charge of the installation at the Workhouse at a weekly salary of £3 13s. 6d.

The first annual dinner of the staff of the Fulham Borough Council Electricity Department took place on Tuesday, February 9th, at the King's Hall, Fulham. The chair was occupied by the consulting and borough electrical engineer, Mr. Arthur J. Fuller, and the vice-chair by Mr. G. T. Meek, the dust destructor superintendent. Replying to the toast of his health, Mr. Fuller said it was with some fear and trembling that he entered upon his duties just 11 months ago that day. These fears, he was glad to say, had been long since dispelled. In all his 15 years' experience as a central station engineer he had never met a more loyal staff or better set of men. The progress of the undertaking had more than exceeded his expectations; 12 months ago there were 620 consumers connected to the mains, but now there were 1,100, or nearly double. The demand for motive power had increased from 30 H.P. to nearly 400 H.P. This no doubt was due to the very low rate of 1d. per unit, which made the cost of electricity as a motive power 20 per cent. cheaper than gas.

NEW COMPANIES REGISTERED.

Electroid, Ltd. (80,017).—This company was registered on February 12th, with a capital of £60,000 in £1 shares, to adopt an agreement between R. Abrey, of the first part, and E. E. Moody (for the company) of the second part, for the acquisition of the secret process for the manufacture of a composition designated "Electroid," to manufacture and deal in the said composition, and to carry on any business incidental or auxiliary thereto. The first subscribers (each with one share) are:—L. Stokes, 90, Belvedere Road, S.E., clerk; W. Campbell, 1A, Hollywood Road, South Kensington, builder; H. N. Beeman, 2, Copthall Buildings, E.C., secretary; I. Perrott, 2, Copthall Buildings, E.C., director; R. Cheltam Strode, M.B., 7, Union Court, E.C.; L. Owen, 29, Ravenscourt Park Mansions, W. clerk; and H. King, 109, Victoria Street, S.W., secretary. No initial public issue. The number of directors is not to be less than three nor more than seven. The first are L. Stokes, W. Campbell, H. N. Beeman, I. Perrott, R. Cheltam Strode, L. Owen and H. King; qualification, £250; remuneration, £150 each per annum, with £250 extra for the chairman, and 5 per cent. of the distributed profits in excess of 20 per cent. dividend (such additional remuneration not to exceed £5,000 in any year). Registered office, 109, Victoria Street, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Electric Timber Seasoning and Preservation Co., Ltd.—Five debentures, all dated January 14th, 1904, (1) to secure £1,482 10s., (2) to secure not more than £131, (3) to secure £225, (4) to secure £200, and (5) to secure not more than £374 15s., all charged on the company's undertaking and property, present and future, have been registered. Holders: G. Mathieu, 78, Blenheim Crescent, North Kensington; H. B. Weaver, 11, Stone Buildings, Lincoln's Inn, W.C.; and E. H. Stevenson, 38, Parliament Street, S.W. A memorandum of satisfaction in full of a charge dated July 30th, 1903, securing £800, has also been filed.

South London Electric Supply Corporation, Ltd. (50,392).—Issue, on January 28th, of £50,000 5 per cent. debentures to "Bearer," part of series created January 19th, 1904, to secure £100,000. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

British Electric Calibrated Fuse Co., Ltd. (78,488).—Issue, on January 25th, of £300 debentures, part of series created December 4th, 1901, to secure £8,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: J. Lang, 137, Fenchurch Street, E.C. No trustees. Previously issued of same series: £750.

Northampton Electric Light and Power Co., Ltd. (28,640).—Issue, on January 19th, of £400 debentures, part of series created June 3rd, 1896, to secure not more than two-thirds of the paid-up capital for the time being, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series: £31,700.

Aron Electricity Meter Co., Ltd. (58,650).—This company's annual return was filed on January 8th, when 125,000 ordinary and 124,896 preference shares had been taken up out of a nominal capital of £250,000 in £1 shares (125,000 preference). £1 per share has been called up on the preference, resulting in the receipt of £124,948 10s., including £52 10s. paid on 104 forfeited shares. Ordinary shares considered as fully paid. Mortgages and charges: £56,900.

United Electric Light and Power Supply Co., Ltd., Manchester.—Issue, on January 14th, of £825 6 per cent. first mortgage debentures, part of series created March 17th, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital and buildings, machinery and other property at Guimarães, Portugal. No trustees. Previously issued of same series: £1,550.

Bullers, Ltd.—This company's annual return was filed on January 5th, when 15,000 ordinary and 15,000 preference shares had been taken up out of a nominal capital of £400,000 in £10 shares (20,000 preference). £10 per share has been called up on 7 ordinary and 15,000 preference, resulting in the receipt of £150,070. £143,930 is considered as paid on 14,993 ordinary shares. No mortgages or charges.

Evershed & Vignoles, Ltd., electrical engineers, London.—A trust deed, dated January 18th, 1904 (supplemental to a trust deed of February 11th, 1902, securing £15,000 debentures created by resolution of even date), has been registered. Property charged: £2,500 capital uncalled on shares issued since date of principal trust deed. Trustees: Law Guarantee and Trust Society, Ltd., 49, Chancery Lane, W.C.

Marconi International Marine Communication Co., Ltd. (65,759).—This company's annual return was filed on January 2nd, when 204,056 shares had been taken up out of a nominal capital of £350,000 in £1 shares. 15s. per share has been called up on 99,056 shares, resulting in the receipt of £74,179. £113 remains in arrears. 105,000 shares are considered as fully paid. No mortgages or charges.

Mutual Telephone Co., Ltd. (56,627).—This company's annual return was filed on January 9th, when 6,283 preference and 10,348 ordinary shares had been taken up out of a nominal capital of £250,000 in £5 shares (50,000 5 per cent. cumulative preference). 6d. per share has been called up on 16,631 shares, and £1,184 7s. 6d. has been received (including cash paid in advance). No mortgages or charges.

Electric Supply Corporation, Ltd. (52,036).—This company's annual return was filed on November 9th, when 3,400 shares had been taken up out of a nominal capital of £250,000 in 50,000 shares of £5 each. £4 10s. per share has been called up, and £14,759 10s. has been received (including £130 paid in advance of calls). £670 10s. remains in arrears. No mortgages or charges.

Electric Light and Power Co. of Japan, Ltd.—This company's annual return was filed on January 14th, when 7 shares had been taken up out of a nominal capital of £3,000 in £1 shares. No calls have been made. No mortgages or charges.

ELECTRICITY SUPPLY ACCOUNTS.

Taunton Municipal Electrical Supply.

During the period ending March, 1903, the Taunton Electrical Department obtained the full advantage of the traction supply to the B.E.T. Co.'s lines in the borough, and with improvements in other directions, the output has now grown to over a half million units per annum.

The works costs show a great improvement over those for the preceding period, and are now under 2d. per unit.

The prices charged are: Private lighting, 6d. and 3d. per unit, on the maximum demand system; power and heat, 2d. per unit; traction, 2d. to 1d. per unit, depending on amount.

Mr. E. B. Thorahill is the borough electrical engineer.

General Statement.

For periods ending—	12 mths., Dec. 31st, 1901.	15 mths., March, 1903.
Total capital expended	£52,586	£62,174
Number of units sold—		
Private supply	224,353	340,422
Public lighting	137,040	189,580
Traction	24,514	116,271
Total number of units sold	385,907	646,273
Equivalent No. of 8-c.p. lamps connected	23,995	26,659
H.P. of motors connected	—	210 H.P.
Number of public lamps	72 arc 225 inc.	72 arc 241 inc.
Maximum load in KW.	435	462
Revenue account—		
Gross revenue	£7,722	£11,060
„ expenditure	£4,991	£5,291
„ profit	£2,731	£5,769
Average price obtained—		
Private lighting	4·35d.	4·35d.
Public lighting	3·94d.	3·71d.
Traction	2·00d.	1·92d.
Gross revenue	£11,060 = 4·12d. per unit.	
Works and distribution costs (inc. pub. ltg.)	£3,469 = 1·29d. „	
Total works costs	£5,291 = 1·96d. „	

Profit Statement.

Interest on loans	£2,420
Sinking fund	2,019
Balance on year's working	1,330
Gross profit	£5,769

Including sundry amounts brought forward from the preceding year, a total balance of £5,903 was available, and after meeting financial charges, a balance of £1,464 was distributed: £670 to the district rate, £700 to the reserve fund (which now amounts to £1,400), bad debts, £20, and balance carried forward, £74.

Ealing Municipal Electrical Supply.

The Ealing Electrical Department is to be congratulated on its growing popularity and improved finances during the year under review. With the improved output, works costs have come down by nearly ¾d. a unit.

The last year's working resulted in a credit balance of £3,083, as compared with £421 in 1902, and it was utilised by the department to reduce the deficit of the opening years. The prices charged are: Private lighting, 6d. to 4d. per unit sliding scale, 8d. and 3d. maximum demand; power, 3d. and 2½d. per unit. The borough electrical engineer is Mr. J. Douglas Knight.

General Statement.

For year ending March 31st—	1903.	1902.
Total capital expended	£137,549	£116,311
Number of units sold—		
Private supply	586,365	453,387
Public lighting	279,065	252,399
Total number of units sold	865,430	705,786
Equivalent No. of 8-c.p. lamps connected	57,057	45,448
No. of motors connected	—	—
Number of public lamps	72 arc 1,216 inc.	72 arc 1,113 inc.
Maximum load in KW.	—	—
Revenue account—		
Gross revenue	£17,725	£14,741
„ expenditure	£7,510	£7,183
„ profit	£10,215	£7,558
Average price obtained per unit—		
Private lighting	5·85d.	5·85d.
Public lighting	2·84d.	3·38d.
Gross revenue	£17,725 = 4·92d. per unit.	
Works and distribution costs (inc. pub. ltg.)	£6,153 = 1·71d. „	
Total works costs	£7,510 = 2·09d. „	

Profit Statement.

Interest on loans	£3,640
Sinking fund	3,492
Balance carried to profit and loss account	3,083
Gross profit	£10,215

CITY NOTES.

British Electric Transformer Co.

Mr. E. Phillips presided on Wednesday at Salisbury House, E.C., over the first annual meeting of this company.

Before the auditor's certificate was read, Mr. Black said he wished to move the following resolution:—"That this meeting be postponed until after the extraordinary general meeting has been held, and until the two new directors to be elected might have an opportunity of considering and approving the accounts in company with the members of the existing board." They were there as commercial men to transact business, but they would notice the absence of several old faces from the board. It was obvious, however, that they must have men of business experience on the board in whom they had confidence, and it was a matter of importance that the chairman, Mr. Bain, and Mr. Petersen, who might be called the father of the company, had refused to serve with the other directors.

The Chairman said the motion was not acceptable to the board, and he proposed to go on with the ordinary business.

Mr. Petersen protested against a strange solicitor (Mr. F. Crisp) being brought in, and said the old solicitors, whose names were on the prospectus, ought to have been present on the invitation of the board. He protested against the directors browbeating them in the way they were attempting to.

After some further discussion, the Chairman proceeded to move the adoption of the report, and said the accounts pretty well explained themselves. There was unissued ordinary shares of £5,500, and they had also 19,000 preference shares unissued, which, if the business was allowed to go on, they might one day issue at a premium. They would see that two new bays had been put in to the company's works, and they were now proceeding with the equipment of the bays, and in connection with that it was anticipated that £3,000 would be spent, and also in the heating of the works. The whole of the work would be finished about the end of May. When they got the bays completed they would be better able to cope with the work in hand. The dividend recommended on the ordinary shares was 7 per cent., and seeing that the year had not been a fat one, this was very satisfactory, and was really better than the dividends paid in the old company. The dividend of 7 per cent. in the new company worked out at 10½ per cent. on the old shares, inasmuch as the old shareholders had got 50 per cent. more in the new company than the whole. He had a report from the manager, who stated that the works were going on satisfactorily, and the output for 1903 had been greater than that of any previous year. The orders on the books far exceeded any previous figures, and they had sufficient work in hand to take them well into the year. Competition was still exceedingly severe, but it was from firms domiciled in this country. The Chairman proceeded to deal with the personal disagreement between Messrs. Bain and Petersen and the three other members of the board, and read voluminous correspondence which had taken place between himself and Mr. Bain with reference to the payment of costs with respect to foreign patents by Mr. Billington (a director).

Mr. Beavor again raised the question of the old solicitors (Messrs. Faithful & Owen) being present, and Mr. Petersen moved a resolution that they be invited, and declared it carried by the meeting.

The Chairman continued to deal with the correspondence which had passed, and said what it came to was whether the three members of the board should retire and leave the company to Mr. Bain, or whether they should exercise their power and remove Mr. Bain as the chairman. They followed the latter course. The original cause of the unpleasantness was years

ago when Mr. Bain and Mr. Billington had a very serious disagreement, which nearly got into the police-courts. In conclusion, he said the whole question was whether the shareholders would support Mr. Bain and his friends, or Mr. Berry, who was an expert, and who held 32,000 shares in the company, and Mr. Billington, who was responsible for a great share of the prosperity in the past.

Mr. Berry seconded the resolution, and said he was the largest shareholder in the company; their idea in enlarging the company was to broaden their business in India, Australia, Africa, and other places.

Mr. Petersen characterised the statement that Mr. Bain and himself wanted control of the company as an absolute falsehood. All they asked was that two independent directors should go on the board. Mr. Bain and himself were really responsible from the start of the old company, it was an untried invention, and they worked it out. Mr. Billington was paid £25,000 for the patents. He did not for a minute say the accounts were wrong, but he moved that they be rejected until after an extraordinary meeting had been held for the election of two directors.

Mr. Rolle said if two independent shareholders went on the board they would hold the balance between the two parties, and he and Mr. Beavor had been asked to go on the board. The whole trouble was due to personal disagreements which had occurred. So far as Mr. Beavor and himself were concerned, they had no axes to grind, and their only wish in going on the board was to see that recriminations ceased.

Mr. Bain said that Mr. Petersen and himself had quite made up their minds to resign, but they were prevailed upon by an influential number of shareholders to withdraw their resignations. He proceeded to read further correspondence which had taken place on the question of the costs of transferring the patents from the old company to the new, which he contended should have been paid by Mr. Billington. He said he was only acting under the advice of the company's solicitors, who distinctly stated that if Mr. Billington did not pay the cost of the transfer of these patents, it was a variation of the agreement in the prospectus.

The motion for the adoption of the report was carried, on a show of hands, by 25 votes to 22, and Mr. Petersen demanded a poll.

The resolution for the payment of dividend was lost, and the Chairman demanded a poll on this.

Mr. Billington moved, and Mr. Berry seconded, a motion for the election of Mr. C. T. Elmslie, and this was defeated. The chairman demanded a poll.

Mr. Rolle moved, and Mr. Beavor seconded, the re-election of Mr. Bain, and this was carried. A poll was also demanded on this by the chairman.

The Chairman, in answer to a shareholder, said that he held sufficient proxies to carry his resolutions.

On a poll being taken, the accounts were adopted by 2,725 votes.

Waterloo and City Railway Co.

The half-yearly meeting was held on February 11th at Waterloo Station.

Sir Chas. Scotter, who presided, said that no doubt a few of the shareholders would be a little disappointed at the result of the half-year's working, but really there was no cause for any anxiety, as he would be able to show that the circumstances were entirely exceptional, and that the steady progress of that little railway would continue. The revenue of the railway showed a steady progress right up to August, but on August 10th, as they would remember, a deplorable accident occurred on the Metropolitan Railway of Paris, by which a large number of lives were lost, and there was no doubt that that was the cause of the falling off of the traffic on their railway. During August, September, October and November the traffic fell off, and then it began to pick up a little; and now the loss occasioned by the accident had been overcome, and they were again showing a steady, but sure, progress on the railway. The loss of life in Paris was due, without doubt, to the whole of the lights going out, and it was only right that the people of London should be assured of the absolute safety of the tube railways in London. On the Waterloo and City Railway the lighting of the stations and tunnel was absolutely independent of the motive power which worked the trains, so that in case of accident to the train, the lighting of the stations and tunnel would not be interfered with in the slightest degree; but, in addition, they had an installation of gas, and in every carriage they had an oil lamp. Further means were provided for passengers to leave the tunnel in case of accident by walking on a pathway to the stations at either end, and there would be no risk of passengers coming into contact with electricity on the third rail, because every driver of a motor could cut off the electricity from the centre rail without communicating with the generating station at Waterloo. Their passengers need have no fear of meeting another train in the tunnel, because the driver, by cutting off the electricity from the third rail, stopped every train at once. He said without hesitation that one of the safest places in London for a man was the City and Waterloo Railway. In addition to that, the tunnels were well ventilated, for there were no fewer than 20 cross passages cut between the tunnels, and at the Waterloo end they came out into the open. The line had been open about 5½ years, and, including season ticket holders, it had carried about 30,000,000 people without accident of any kind or description. That spoke volumes for the way in which the traffic had been worked. In fact, he might say, as an old railway man, that the regularity of the service and freedom from breakdowns during the past 12 months was somewhat remarkable. The total delays from all causes in the 12 months only averaged six minutes per week—an average of one minute per day. The motors were at each end of the train, for they had not got what was known in the electrical world as the multiple unit system. The system they adopted was for the particular work they had to do, for they had no long trains. They ran a maximum of four coaches, and during the greater part of the day they only ran one coach, so as to economise in working. The revenue account was £300 less than in the corresponding period, and there was a decrease of 66,277 passengers. He had explained the reason for the decrease. There was a slight increase in the working expenses, because they included £160 paid under the Workmen's Compensation Act to an employé who was hurt. Had it not been for these two causes they would have paid 3½ per cent., the same as 12 months ago. The traffic in the current half-year was growing gradually, and there was no reason why, in the course of time, the railway should not go on increasing its dividends by small amounts. The balance available for dividend, after meeting prior charges, was £8,450, and when the 3 per cent. dividend was paid, it would leave £554 to be carried forward. He thought, on the whole, that was a satisfactory result.

The report was adopted.

Cambridge Electric Supply Co.

The directors' report for 1903 shows that the progress of the company continues to be satisfactory:—

The additional Parliamentary powers have been obtained, and these enable the company to supply electrical energy in the district immediately surrounding the borough. Mains have now been laid in several portions of this area, and a supply of electrical energy commenced.

The directors, having further considered the question of moving the generating station, have come to the conclusion that, having regard to all the difficulties and expense that this course would entail, it is impracticable. They are therefore taking steps to utilise the whole of the site of the existing works for electric generating purposes, and have also purchased some additional freehold property in Thompson's Lane, to which they intend to move the stores and workshops.

These alterations and the additional machinery and mains that are now required to meet the increase in the company's business necessitate further capital expenditure. The directors therefore propose to make a further call of £1 per share, payable on March 31st next, and to create £30,000 of 4½ per cent. debentures, a portion of which will be offered to the shareholders during the present year.

During the year 1903 there has been added to the company's mains the equivalent of 5,482 8-c.p. lamps, making the total 44,088. The number of units supplied has been 471,510, an increase of over 40,000 units.

The company, after paying all charges and placing £1,500 to depreciation fund account, has a balance of £6,267 12s. 3d., which, added to £688 1s. 6d. brought forward from last year, makes £6,955 13s. 9d. An interim dividend of 2½ per cent. (absorbing £1,782 10s. 4d.) and interest on loan (£323 3s. 10d.) have already been paid, leaving a net balance of £4,849 19s. 7d. Out of this the directors recommend the payment of a dividend of 4½ per cent., making 7 per cent. for the year. This will absorb £3,507 11s. 8d., leaving a balance to carry forward subject to fractional adjustment of income-tax of £1,342 7s. 11d.

Baker Street and Waterloo Railway Co.

Mr. T. J. Hare presided at the meeting held at Hamilton House on Tuesday. The report, the adoption of which he moved, showed that the capital expenditure during the half-year ended at December, 1903, amounted to £204,176, and the estimated expenditure for the current half-year is £300,000. The report by the engineers (Sir B. Baker and Messrs. W. R. Galbraith and R. F. Church) shows the progress made with the works since August last, as follows:—

Waterloo to Dorset Square Contract.

Tunnelling.—With the exception of the cross-over road tunnel at the northern end of the contract, a length of 31 lineal yards, the whole of the tunnels have been driven and the enlargements for the Regent's Park Station are nearly finished.

Stations.—At Waterloo the high level works are finished with the exception of the entrance in York Road and the internal fittings of the booking hall. At the low level the passenger subways are nearly completed, but the station tunnels have to be lined and platforms finished.

Embankment Station.—The inclined tunnel to communicate with the District Railway has been finished to the point where it joins the interchange booking hall near the bottom of Villiers Street.

Trafalgar Square Station.—At the high level the booking hall and lift chamber has been built and is nearly covered in. All the shafts are sunk and below ground the opal lining of the station tunnels is in progress.

Piccadilly Station.—Work has been resumed here, and the remainder of the site cleared ready for sinking the stair shaft.

Oxford Street Station.—The surface is now ready for the station building, but a short low level passage required by the Board of Trade remains to be constructed.

Regent's Park Station.—The contractors are preparing to sink the shafts in Park Square Gardens, possession of the site having been obtained.

Baker Street Station.—At the low level all the subways are completed with the exception of glazed lining. The stair shaft is to be sunk at once, and the foundations for part of the station building above ground have been put in.

Elephant and Castle Extension.

Tunnelling.—Over 1,450 lineal yards of tunnel have been driven, and some considerable sewer diversions completed.

About one-fourth of the excavation at the depôt has been removed.

Additional machinery is being erected at Kennington Road Station for expediting the completion of his extension.

The Chairman said that the railway would take its supply from the great power station which was building at Lot's Road, Chelsea, and that station would be ready by the time this railway is completed. The directors recently received a draft copy of precautions which it was proposed should be taken, so that the risk of accidents on underground railways should be lessened. These precautions showed the care that was being taken by the Board of Trade to ensure absolute safety for travellers on underground lines. The company was promoting a Bill to seek powers for the enlargement of certain of the tunnels for station purposes, to purchase additions

land, and raise further capital. That capital would be required to pay for extra land and stations and other improvements and additions not contemplated when the construction contracts were placed.

Sir Algernon West seconded, and the report was adopted.

The retiring directors and auditors were re-elected, and a special meeting which followed heard the main heads of the new Bill stated by the solicitor, and approved thereof.

Anglo-American Telegraph Co.

In the absence of Mr. Bevan (the chairman) in Egypt, and of Sir Gerald Fitzgerald (the deputy chairman) who has lately undergone a surgical operation, Mr. S. Barber was voted to the chair at last Friday's meeting. He said that the year 1903 had shown a falling off in traffic as the prosperity of telegraphic enterprise was dependent upon the prosperity of trade to a large extent. The balance left for dividend was £109,628, as against £117,206 in 1902, a decrease of £7,578. After placing the usual £24,000 to renewal, they were able to give a total dividend for the year on the ordinary stock of £3 1s., as compared with £3 0s. 6d. in the previous year, the preferred stock thus recovering its full 6 per cent., and the deferred its 2s. per cent., which was 1s. more than last year. They owed a good deal of the profit to the earnings of the ship *Minia*. She had earned £19,290 in the year doing repair work on behalf of their partners, the increase being £14,890. The increase in the expenses was due to the increase of salaries and wages at stations, which were governed by the value of the employment and exacting demands of the public for speed and accuracy. The renewal fund stood in the accounts at £982,103, but the present market price was £44,000 less. The necessity for that fund was apparent when they considered that during the past year the 1873 cable was interrupted twice, on one occasion for 20 days, and another for 10 days. The 1874 cable, which was also interrupted three times last year for shorter periods, and out of the whole seven pool cables, four were out of order at one time, but fortunately not for long. The directors were giving their most careful consideration to the question of dealing with the renewal fund, and the chairman quoted remarks which had been made under this head by Mr. Bevan at the last few meetings. They had made two deep-sea repairs and eight repairs of shorter sections during the year, but at present all the cables were in good working order, and had been practically so from the end of the year. They had carried 1½ millions more words than in 1902, and they had brought down the distance between London and Australia to 3½ min., a record which would not easily be beaten. In regard to the outlook, business generally, was very slack, and he could not hold out any very great hope for the current year.

A lengthy argument ensued in which the views of the deferred shareholders, respecting the renewal fund, were once more put forward, and there is every prospect of still greater prominence being given to the question at the next meeting. The report was adopted.

The unavoidable absence of the chairman (Mr. F. A. Bevan), whose conduct of the meetings for years past has led shareholders to expect a clear and authoritative expression on any point that might be raised, caused the utmost disappointment. Not that the board lacks strong men, who can give a plain answer to a plain question and show some semblance of authority, but they were not holding the reins, though one of them came to the rescue on the deferred dividend question. It is not surprising that some of those present expressed a desire that the meeting should send best wishes to Mr. Bevan, in Egypt, that he might come back much the better for the change which he had felt compelled to take as the result of a severe bereavement.

Imperial Tramways Co.

The directors' report for 1903 gives the following results:—

Middlesbrough, Stockton and Thornaby Electric Tramways.—The gross receipts from this undertaking amounted to £49,963, and the number of passengers carried was 9,576,125, compared with totals of £49,255 and 9,367,027 in the preceding year. The net profit for the year is £16,354. A Bill is being promoted in the present session to authorise extensions of the system from Middlesbrough to Ormesby, South Bank and Eston, and for doubling the existing lines in the neighbourhood of Stockton Racecourse, which will afford additional facilities for the conduct of heavy traffics.

London United Tramways (1901) Ltd.—No variation has been made during the past year in the company's investment in this undertaking, which is represented by 41,500 5 per cent. cumulative preference shares of £10 each fully paid, and the net income derived for the year amounted to £19,712. The London United Co. continues to show satisfactory progress, and has just announced the usual dividend of 8 per cent. upon its ordinary capital.

General.—The net revenue account for the year shows an available balance of £41,899, and after payment of interest on the debenture stock for the whole year, and interim dividends on the preference and ordinary shares in respect of the half-year to June 30th last, amounting together to £26,067, it is proposed to appropriate the balance as follows:—Dividend at 6 per cent. per annum on the preference capital (paid on January 1st last) £5,725; final dividend at 10 per cent. per annum (making 9 per cent. for the year) on the ordinary capital (less income-tax) £9,542, and to carry forward to the next account £566. The reserve funds remain at the sum of £120,472.

London United Tramways (1901), Ltd.

The directors' report, to be submitted at the meeting on Monday, February 22nd, says that the operation during the past year of the company's undertaking has resulted in gross receipts amounting to £280,242, and the working and general expenses and renewals to £176,392, leaving, with the balance brought forward from last account, a net revenue of £108,108.

After payment of the debenture interest and the dividends on the 5 per cent. preference shares, there remains £49,281, out of which an interim dividend at the rate of 8 per cent. per annum, less income-tax, amounting to £24,065, was paid in August last, leaving an available balance of £25,216. Of this amount it is proposed to appropriate £24,429 in payment of a final dividend on the ordinary shares for the half-year ending December 31st last, at the rate of 8 per cent. per annum, less income-tax, and to carry the balance of £787 to the credit of the next account. The extensions of the company's system to Hampton Court and the Thames Valley were opened in April last, and the results of the company's operations during the first season, although to be regarded as satisfactory, fall far short of the traffics which would have been secured, without any additional expense, if the weather conditions had been at all normal. The directors had anticipated that under ordinary circumstances the profits of the year would have been sufficient, not only for the dividend, but to set aside a very substantia sum to a reserve fund, the establishment of which the shareholders would probably prefer should now be deferred until the next annual account. It i gratifying to know that whenever the weather conditions favour pleasure travelling, the receipts invariably exceed the estimates which had been formed of this important branch of the traffic. The total number of passengers carried during the year was 45,293,473.

The directors have to report the passing of the Act of last session, under which the company is authorised to acquire additional properties for the purpose of street and road widenings, thus enabling the company to effect the conversion to double track of a number of inconvenient short lengths of single line. The construction of the extension from Hammersmith Broadway to the Uxbridge Road *via* Askew Road, is well in hand, and will shortly be completed and opened for traffic. The provision of this cross-town connecting line will allow of through services between Hanwell, Ealing and Acton, and the District Railway station at Hammersmith Broadway, and so afford residents in the crowded area on the northern portion of the company's system an alternative means of cheap and rapid transit to and from the City. Good progress has also been made with the construction and equipment of the company's line to Uxbridge, *via* Hayes and Hillingdon, about 1 mile of route only remaining to be built.

A Bill was introduced in the present session of Parliament to authorise further extensions of the company's system, including proposed lines from Hounslow along the Staines Road to Staines, and along the Bath Road to Slough and Maidenhead, a line to connect Ealing and Brentford, and a tramway across the new Kew Bridge. The exorbitant demands of most of the local authorities concerned as the condition of their assents, which are indispensable under the existing Standing Orders of Parliament, have, however, compelled the directors to withdraw the proposals, with the exception of the Hounslow—Staines extension. Powers will also be taken under the Bill for the requisite extension of time for construction of the Kingston and Surbiton group of lines which the directors have determined shall be the next in order to be carried out after the works now approaching completion. For the purpose of facilitating the interchange of traffic at Hammersmith between the company's tramways and the Metropolitan District Railway, and also with a view to connecting up the company's authorised tramway from Barnes and Mortlake to Richmond with the main system, the directors are promoting a Bill to authorise underground electric railways to convey the company's cars from the surface of the street at Hammersmith Broadway and at the south side of Hammersmith Bridge, direct to the platform of the District Railway Co.'s Hammersmith Station. It is anticipated that when the electrification of the District Railway has been completed, and their proposed reduced fares have been brought into force, the facilities for through booking and exchange of traffic, which will be afforded by the proposed system of underground railways connecting at Hammersmith, will prove of great public convenience and advantage to the companies concerned.

Westminster Electric Supply Corporation.

The directors' report for 1903 says:—

The supply of current, which on December 31st, 1902, was provided for the equivalent of 602,976 lamps of 8-c.p., had increased by December 31st, 1903, to the equivalent of 662,129 lamps, and applications for supply continue to come in at a satisfactory rate. The length of roadway in which continuous-current mains have been laid, now exceeds 73 miles, making about 279 miles of ways, into which upwards of 230 miles of copper (strip and cable) have been drawn. In addition, three miles of trunk mains (12 miles of ways) are laid in the company's area to connect the stations with the Central Electric Supply Co.'s station at St. John's Wood. The system of public lighting undertaken by this Corporation continues to give great satisfaction. The station of the Central Electric Supply Co. at St. John's Wood has been at work and has supplied a considerable amount of current to this company during the year. In the initial stages of working, the cost of production is necessarily high, but the increased demand during the current year will enable the Central Co. to supply at a considerably lower rate to the Westminster and St. James' Companies.

The directors have acquired from the Duke of Westminster a long lease of a site in Duke Street, Mayfair, for the provision of an underground transforming station. The contract for the building works (which has already made considerable progress) has been placed with Messrs. George Trollope & Sons, Ltd., and the first section of plant for the equipment of the station is on order. This station will be ready for the heavy load of next winter, when the capital expended on the work will commence to be remunerative. The result of the year's working is again very satisfactory, and the directors are pleased to be able to recommend the payment of an increased dividend. Having in view the desirability of a further reduction in the rates for supply, such reduction tending in the earlier stages to affect the balance available for distribution to the shareholders, they have thought it advisable with a view to this and other contingencies to carry forward a larger amount than in previous years, pending the increase in revenue which may be expected to follow.

An interim dividend, at the rate of 13 per cent. per annum on the ordinary shares and the dividend on the 5 per cent. preference shares, for the half-year ending June 30th, 1903, has been distributed. After allowing for depreciation, sinking fund, &c., the net balance is £49,586, from which must be deducted the second half-year's dividend on the preference shares which absorbed £3,357, leaving a balance of £46,239. Out of this the board recommend the payment of a dividend at the rate of 14 per cent. per annum less income-tax, for the past half-year, carrying forward a balance of £9,494.

Statement of Electricity Generated, Sold, &c.

Board of Trade units generated.	Quantity utilised.			Quantity expended in distribution.			Total quantity accounted for.	Quantity unaccounted for.	No. of lamps on circuit, December 31st, 1903.
	Sold to consumers.	Used on works for lighting, meter testing, &c.	Total.	In batteries.	In feeders.	Total.			
14,216,263	13,086,596	160,238	13,246,834	25,905	848,446	874,351	14,121,185	95,078	662,129

Smithfield Markets Electric Supply Co.

MR. H. S. LEON presided at the meeting held at Winchester House last Friday. He referred first of all to the accident which had taken place at the station several days earlier, occasioning loss of life. It was the first accident that had ever taken place at their works; he was not able to state exactly the cause, no doubt the Board of Trade would hold an inquiry. In spite of the price of current having been reduced to a uniform rate, the net profit was £628 more than in the previous year, being £4,811 against £4,183, an increase of 15 per cent. The engines and dynamos were in a better state than when they bought them, and the new engine and dynamo which cost £4,182 (less £1,957, the value of the old one) had been running for three or four months, and would enable them to work more economically in 1904. All the cost of the new machine had been paid for out of earnings. They raised no new capital, but borrowed from their own reserves. Although the output of electricity was 7 per cent. greater, the cost of production decreased by £200. £1,500—an increase of £500—had been placed to depreciation, making a total of £2,965 on that account. Another £2,000 had been added to reserve, raising that to £4,000. They would have to buy a new boiler and then they hoped there would be an end of their capital expenditure.

MR. SCHENK seconded the adoption of the report, and it was agreed to.

The auditor was re-elected, and in thanking the meeting he referred to a remark of the chairman's that the depreciation and reserve funds should be lumped together. He himself thought they ought to be kept distinct; the chairman had said that he would like the reserve fund to be used to pay off debentures, but the depreciation fund was for keeping the plant right. One fund must be kept for one purpose, and the other for another.

Blackheath and Greenwich District Electric Light Co.

THE report for 1903 shows an available balance of £13,951. After deducting debenture interest, paying 7 per cent. preference dividend, allocating £1,250 to depreciation, a balance of £5,220 is carried forward. The undertaking of the Crystal Palace District E.S. Co. is to be purchased. The lamps connected increased by 15,624 to 60,540, and the consumers from 1,234 to 1,734. The gross revenue was £19,450, or £5,116 in advance of 1902, the expenditure being £8,409, an increase of £1,420. The net revenue was £11,041 against £7,355 (increase £3,686).

B.E.T. Co.—We are asked to publish the following:—"Statements have been circulating to the effect that the recent issue of second debenture stock by the British Electric Traction Co., Ltd., was not a success, and the price of the shares has been falling in consequence. As a matter of fact, the issue was entirely underwritten by responsible firms, and the failure of the public to take up the whole of the stock offered does not affect the financial position of the company in the least degree, as, of course, it will get its capital just as if the public had subscribed for the whole issue."

Bournemouth and Poole Electricity Supply Co.—The directors recommend a dividend on the ordinary shares of the company at the rate of 8 per cent. per annum, less tax, for the year ended December 31st, carrying forward over £3,000 after providing for depreciation, &c.

Stock Exchange Notice.—The Committee has been asked to allow the following securities to be quoted in the Official List:—Electric Construction Co., Ltd.—Further issue of £12,500 4 per cent. perpetual first mortgage debenture stock.

Brompton and Kensington Electricity Supply Co.—The report for 1903 states that the revenue credit balance is £29,234, which, with £888 carried forward, and £335 balance of interest received, makes a total of £30,457. It is proposed to apply £7,500 to depreciation, £4,732 for dividend on 7 per cent. preference, £13,239 for dividend of 10 per cent. for the year on the ordinary shares, and £807 for directors' additional remuneration, leaving £4,179 to be carried forward.

Prospectus.—The Charing Cross and Strand Electricity Supply Corporation is offering to its existing shareholders an issue of 10,000 ordinary shares of £5 each, ranking for dividend as from January 1st, 1905, at £6 15s. per share, and 10,000 4½ per cent. cumulative preference shares of £5 each, ranking for dividend as from February 15th, 1904, at £5 2s. 6d. per share. Applications have to be lodged before February 26th.

Brockie-Pell Electric Arc Lamp Co.—The annual meeting was held yesterday, and the report showed that after writing off £632 for depreciation on tools and patterns, there remains a debit of £65 to be carried forward. Depression of trade and keen competition led to reduced turnover and smaller profits.

STOCKS AND SHARES.

Wednesday Evening.

IN several directions business in the Stock Exchange shows a faint indication of revival, although its coming is so slow as to forbid hopes of a general improvement. The position in the Extreme East cannot fail to have a certain amount of influence upon money for some time to come, and although there is no difficulty experienced in arranging short loans on easy terms, the likelihood of a reduction in the Bank Rate is considered by good authorities as postponed. We observe that the Finance Committee of the Fulham Borough Council has been considering how to raise a loan of £25,000 required in connection with the electric light and dust destructor undertaking. It is suggested that the money should be borrowed from an insurance company, as being cheaper than the London County Council.

For all the comparative ease of the Money Market, the cry goes up that the public will not look at new issues. That this is not always the case was shown, of course, by the favour extended to the recent Edmundson's appeal. Now there comes the Charing Cross and Strand, with offers of 10,000 Ordinary shares at 6¾, and 10,000 4½ per cent. cumulative Preference at 5½, the nominal values being £5 in each case. The issue has been underwritten, says the prospectus, but the terms are not stated, and February 26th is the last day for sending in applications. The allotments are not made *pro rata*, but a sensible arrangement provides that members who apply will receive an allotment of at least the proportionate shares to which they are entitled in respect of their present holding.

On this new issue the price of the Ordinary shares at 8 has fallen 16s., allowing for the dividend of 4s. deducted, but the Preference at 5½ are unchanged, although they are also *ex*, their dividend being 2s. 3d. per share. Shareholders should see to it that they do not fail to make application for these new shares; the prices of issue constitute a bonus in themselves, and underwriting seems almost superfluous.

One of the best reports of the Electric Supply companies is that published by the Westminster, and the shares at 13 look reasonably cheap. Besides paying 13½ per cent. for the year—a record dividend in the history of the undertaking—the carry forward has been increased, while the figures relating to the amount of new business achieved in 1903 are decidedly good. City Lights are up 10s. to 11, upon the 6 per cent. dividend, with £45,500 to reserve, the latter item being particularly liked. A fall of 10s. has left Metropolitans at 18, and the other fluctuations are too small to mention, being caused by the dividend reductions in several cases.

After much postponement, the Great Northern and City line is at last open to passenger traffic, and now all that remains to be seen is how the public will take to London's latest tube. The Preferred shares stick at 7½, and the recently-issued Deferred are still unmarketable. Central London Ordinary has advanced a point to 9½ *ex* dividend, but the other two stocks of the Twopenny Tube, as well as City and South London Ordinary, have suffered no change on the week, taking the dividends into account. Districts are dull at 33, but Metropolitans hardened a little to 84½ *xd*. Waterloo and City is 92½. Several steam railway companies, and other bodies, have signified their intention to oppose the Bill for the East London and Lower Thames Electric Power undertaking. East London Railway stock has fallen ¼ to 4¾ middle.

The London United Tramways announce a dividend of 8 per cent. on the Ordinary, the same rate as was paid a year ago; and the report blames the weather for increasing the cost of working to such an extent, that a gross traffic increase of £57,900 left a net improvement of only £2,600. It is a thousand pities that the creation of a reserve fund is again postponed, and the bagatelle of £800 carried forward looks exceedingly inadequate for a concern of such magnitude. The Preference shares are 11½, and the Ordinary stand at 17 to 19; there is not enough doing in these last to enable a close price being quoted.

In observing last week that British Electric Tractions were not a good market, some kind of hint was ventured as to what has now happened, the shares having fallen to 10, a drop of 20s. since we last wrote, and of 30s. in a fortnight. It is quite true that the last issue of Second Debenture stock was guaranteed, but although the British Electric Traction Co. gets its money, it does not look well that the public should have provided so small a proportion.

Sellers have been prominent this week, and the support extended was not enough to stay the flatness. It may be mentioned in passing that Mr. E. Garcke, according to the new volume of the "Directory of Directors," is now a director of only 15 companies, which is eight less than he was connected with in the same capacity a year ago.

Scarcely a change has to be noted in the telegraph list. Eastern 3½ per cent. Preference stock is down a point to 88½; Globe Telegraph and Trust Preference shares are ¼ easier at 12¼, and there the fluctuations finish. Telephone descriptions are equally lifeless, and none of the National issues have quotably moved, although late this (Wednesday) evening, a dealer in the market bid 103½ for the Preferred stock.

British Westinghouse Preference are 4 middle for the old and new shares alike, both being *ex* dividend now. The 4 per cent. Debenture stock is 94½, and British Thomson-Houston 4½ per cent. Debenture 104. The General Hydraulic Power Co. is to pay a dividend of 5 per cent., making 7½ per cent. for the year, and the price of stock is about 135. New Henley's Ordinary have hardened to 1⅝ premium.

N.E. Railway.—The electrical trains began their regular running on Tuesday between Newcastle-on-Tyne and Tynemouth, a distance of eight miles. A few weeks will be occupied in training drivers, and it is hoped that the vehicles will be used for the conveyance of passengers in less than a month. Lord Ridley stated at the recent meeting of the company that the electric tramways, which now run from Newcastle to the coast, had taken away 61 per cent. of the local passengers in the last two years.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Feb. 10th.	Closing Quotations Feb. 17th.	Business done week ended Feb. 17th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	101	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½— 3½	2½— 3½	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,950 Red.	100	..	..	..	.. — ..	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	50 — 53	50 — 53	50	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	94 — 96	94 — 96	95½	94½
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	7⅞— 8	7⅞— 8	7⅞	7⅞
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4½— 5½	4½— 5½	5	..
13,333,300$	Commercial Cable	$100	8 %	8 %	..	180 —190	180 —190	..	..
1,841,909	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	89 — 91	89 — 91	90¾	90⅜
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7 — 8	..	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,961	Direct Spanish Telegraph	5	4 %	4 %	..	2½— 3½	2½— 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7⅞— 8⅛	7⅞— 8⅛	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101 %	98 —101%	..	..
60,710‡	Direct United States Cable	20	8½%	8½%	..	10 — 10⅜	10 — 10⅜	10¼	10⅛
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	119 —124	119 —124	121	119
1,955,565	Do. 5½ % Pref. Stock	100	..	..	..	88 — 91	87 — 90	87½	87½
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	108	107
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10⅜— 11½	10⅜— 11½	10⅜	..
830,000‡	Do. 4 % Deb. Stock	Stock	..	..	..	104 —107	104 —107	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	98 —101	98 —101	100	..
200,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	98	..
180,227	Globe Telegraph and Trust	10	5⅓%	..	..	8⅛— 8⅜	8⅛— 8⅜	8	8⅛
180,042	Do. do. 6 % Pref.	10	..	..	..	12½— 12¾	12 — 12½	12½	12¼
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	22 — 23	22 — 23	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	38 — 41	38 — 41	38½	..
100,000‡	London Platino-Brasilian Telegraph, 6 % Debs.	100	..	..	..	100 —103	100 —103	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	102 —104	102 —104	103⅝	103
1,966,667	Do. do. Def. Stock	10	..	4½%	5 %	78 — 81	78 — 81	79½	78⅞
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13¾— 14¼	13¾— 14¼	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	14 — 15	14 — 15	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5⅛— 5⅜	5⅛— 5⅜	..	..
000,000‡	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	95 — 97	95 — 97	95⅜	95¼
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	100 —102	100 —102	101⅜	101¼
179,318	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞— 1	⅞— 1	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000‡	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6¾— 7¼	6¾— 7¼	..	..
8,808	Submarine Cables Trust	Cert.	..	..	..	117 —122	117 —122	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5¾— 6	5¾— 6	5¾	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅝— 5¼	4⅝— 5¼	..	..
179,947‡	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000‡	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	..	11⅜— 12¼	11⅜— 12¼	12⅛	11⅛
75,000‡	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102	99 —102	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜— ½	⅜— ½	..	..
84,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	6⅜	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½— 5½	4½— 5½	..	..
80,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102	99 —102	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4 — 5	4 — 5	..	..
800,000‡	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	87 — 91	87 — 91	..	..
100,000	British Electric Traction	10	9 %	8 %	..	10½— 11½	9½— 10½	10¼	9⅛
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10½— 11¼	10 — 11 xd	11	10⅝
600,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	•122¾	121¾
100,000	British Insulated and Helsby Cables	5	10 %	10 %	..	6 — 6½	6 — 6½	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5½— 5¾	5½— 5¾	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	1/8— 1/8	1/8— 1/8	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	1⅜— 1⅝	1⅜— 1⅝	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	1 — 1¼	1¼— 1½	..	..
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	98 —101	97 —100	..	..
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80	75 — 80	..	..
85,000	Callender's Cable Construction shares	5	20 %	15 %	..	10⅜— 11⅛	10½— 11½	11⅛	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼— 5⅝	5¼— 5⅝	..	..
90,000‡	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	106½	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	94 — 97	93 — 96 xd	94⅛	94
494,093	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	96 — 99 xd	99	..
494,998	Do. do. Def. do.	Stock	4 %	4 %	4 %	91 — 94	87 — 90 xd	..	..
1,380,000	City and South London Railway	Stock	2 %	3½%	2⅝%	50 — 53	49 — 52 xd	51	50
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	5 %	..	1¾— 2	1¾— 2	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	97 —100	97 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	¼— 1⅝	¼— 1⅝	..	..
344,023‡	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000‡	Do. do. 5% 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1½— 1⅝	1½— 1⅝	1⅝	1⅜
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2½— 3	2½— 3	..	..
82,500‡	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9¼— 9⅝	9¼— 9⅝	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
85,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	12 — 13	12 — 13	12⅝	12¼
85,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	5⅛	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19	18⅜— 19	18⅜	..
800,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅛— 5	4⅛— 4⅛	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10⅜	9⅜— 10½	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	33 — 36	33 — 36	34½	33⅜
150,000‡	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	102½	..
540,000‡	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations Feb. 10th.	Closing Quotations Feb. 17th.	Business done week ended Feb. 17, 1904. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	.. .. ..	.. .. ..	.. .. ..	⅜— 1	⅜— 1	..	..
50,000	Do. 7 % Pref.	1	.. .. ..	.. .. ..	.. .. ..	1⅛— 1⅜	1⅛— 1⅜	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	.. .. ..	.. .. ..	.. .. ..	114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 % 8 %	10 %		10½— 10⅝	10½— 10⅝	10½	..
20,000	Do. do. 7 % Cum. Pref. ..	5	.. ..	..		9¾— 10½	9¾— 10⅜	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	.. ..	..		106 —109	106 —109	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 % 10 %	8 %		8⅝— 9⅝	7⅞— 8⅛xd	8	..
70,000	Do. do. do. 4½% Cum. Pref. ..	5	.. ..	..		5⅝— 5⅞	5⅝— 5⅞xd	..	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	.. ..	..		4⅜— 5	4⅜— 5	..	..
40,000	Do. do. 1903	5	.. ..	..		4⅜— 5	4⅜— 5	..	..
250,000	Do. do. 4 % Deb. Stock Red.	100	.. ..	..		103 —105	102 —104	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	4 % 4½%	5⅛%		5⅛— 6	5⅛— 6⅛	..	..
150,000‡	Do. do. % Deb. Stock Red.	Stock	.. ..	..		106 —109	106 —109	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	10	5 % 5 %	..		10½— 10⅝	10⅝— 11⅛	10⅛	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	.. ..	..		13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	.. ..	..		121 —126	121 —126	..	..
300,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	.. ..	..		101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 % 4 %	..		8 — 9	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	.. ..	..		11¼— 12½	11¼— 12½	..	..
400,000‡	Do. do. 4½% Deb. Stock	..	.. ..	..		107 —110	107 —110	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	.. ..	..		99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 % 7 %	..		5⅜— 6⅛	5⅜— 6⅛	6⅛	..
30,000	Do. do. 6 % Cum. Pref.	..	.. ..	..		5⅜— 6⅛	5⅜— 6⅛	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	.. ..	..		103 —105	103 —106 xd	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 % 10 %	12½		11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	.. ..	..		103 —106	102 —105	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	.. ..	..		1⅞— 2⅛	1⅞— 2⅛	2	..
49,840	Do. do. do. 6 % Pref.	5	.. ..	..		5⅛— 6	5⅛— 6	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	.. ..	..		95 — 98	95 — 98	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6¼% 7½%	..		18 — 19	17⅞— 18⅞	..	..
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	.. ..	..		5⅛— 5⅜	5⅛— 5⅜	5⅜	..
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	.. ..	..		109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	.. ..	..		95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 % 6 %	..		13 — 14	13 — 14	..	..
50 000	Do. do. 4 % First Mort. Debs.	100	.. ..	..		99 —102	99 —102	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½% 14½%	14½%		14½— 15½	14 — 15	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	.. ..	..		8 — 9	8 — 9 xd	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	.. ..	..		97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	.. 2½% 4 %			3½— 3¾	3½— 3¾	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	.. ..	..		86 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	.. 1½%	..		3⅜— 4½	3⅜— 4½	..	..
30,000	Urban Electric Supply, Ord.	5	.. ..	..		4½— 5	4½— 5	..	..
80,000	Do. do. 5 % Cum. Pref.	5	.. ..	..		4⅝— 5⅛	4⅝— 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10½% 12 %	13½%		12½— 13½	12½— 13½	13⅛	13
28,141	Do. do. 5 % Cum. Pref.	5	.. ..	..		6 — 6½	6 — 6½	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, February 17th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	,, Nitric	per cwt.	22/-	..
a	,, Oxalic	per cwt.	82/-	..
a	,, Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	,, ,, ...	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£18	..
a	Benzole (90 %)	per gal.	7/-	..
a	,, (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£23	..
a	Lead, Nitrate	per ton	£24	..
a	,, White Sugar	per ton	£31	..
a	,, Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	8d.	..
a	,, Caustic (75/80%).. ..	per ton	£24	..
a	,, Bisulphate	per ton	£35	..
a	Shellac	per cwt.	220/-	..
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	,, Recovered	per ton	£5 10	..
a	,, Lump	per ton	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a	,, Crystals	per ton	£3	..
a	,, Bichromate, casks.. ..	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£130	..
b	,, Wire, in ton lots ..	per ton	£168	..
b	,, Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £130	..
c	Brass (rolled metal 2' to 12') basis	per lb.	6¾d.	..
c	,, Tube (brazed)	per lb.	8¾d.	..
c	,, ,, (solid drawn).. ..	per lb.	7¼d.	..
c	,, Wire, basis..	per lb.	7d.	..
c	Copper Tubes (brazed)	per lb.	9½d.	..
c	,, ,, (solid drawn) ..	per lb.	9¾d.	..
g	Copper Bars (best selected ..	per ton	£70	..

	METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£70	..
g	,, Rod	per ton	£70	..
e	,, (Electrolytic) Bars ..	per ton	£63	..
e	,, ,, Sheets ..	per ton	£73	..
e	,, ,, Rod ..	per ton	£75	..
e	,, ,, H.C. Wire	per lb.	7¼d.	..
f	Ebonite Rod	per lb.	3/3	..
f	,, Sheet	per lb.	3/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	4/3½ to 4/4½	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	,, Pig (Cleveland warrants)	per ton	43/-	5d. inc.
i	,, Forgings, according to size	per ton	From £11	..
i	,, Scrap, heavy	per ton	47/6 to 50/-	..
i	,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£12	..
g	,, ,, Sheet	per ton	£13	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£8 5	..
d	Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d	,, ,, ,, medium	per lb.	2/6 to 3/9	..
d	,, ,, ,, large ..	per lb.	4/- to 7/9	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p	,, rolled bars & rods	per lb.	1/- to 1/3	..
p	,, ,, strip & sheet	per lb.	From 1/1	..
o	Platinum	per oz.	£4	..
p	Silicium Bronze Wire	per lb.	9d. to 11d.	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	,, ,, in bars		£15 to £40	..
g	Tin, Block	per ton	£128 to £129	£1 inc.
g	,, Foil	per lb.	1/6	..
n	,, Wire, Nos. 1 to 16	per lb.	1/7½	..
p	White Anti-friction Metals— "White Ant" brand ..	per ton	£12 to £62	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	,, 6 lea. Flax	per lb.	5¾d.	..
j	,, 8 ply 10 lbs. Russian ..	per lb.	4⅛d.	..
j	,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j	,, 180 lbs. Jute rove	per ton	£11	..
k	Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Feb. 13	1,094	+278	37	45,216	+ 8,846	10	—
Birmingham ..	,, 13	5,317	+319	7	35,957	+ 2,485	3½	—
Bournemouth ..	,, 10	868	—	—	—	—	10½	—
Blackburn	,, 12	768	+ 99	—	38,818	+ 1,864	13½	—
Blackpool	—	—	—	—	—	—	8½	—
,, —Fleetw'd	,, 13	186	— 2	7	1,187	— 16	7½	—
,, —Lytham	,, 11	178	—	15	2,208	+ 1,629	7½	—
Bolton	,, 14	1,579	+ 47	46	83,578	+ 8,922	25	—
Bradford	,, 14	3,379	+154	44	171,590	+22,265	45	—
Brighton	,, 14	709	— 43	—	41,346	—	7½	—
Bristol	,, 12	4,604	+281	—	—	—	28	—
Devonport ..	,, 5	450	+ 63	5	2,358	+ 880	5	—
Dudley—Sto'rb'ge	,, 5	713	+ 35	5	3,623	+ 170	18½	—
Gateshead ..	,, 5	881	+ 67	5	4,424	+ 232	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 5	507	+ 98	5	2,431	+ 868	7½	—
Hartlepool ..	,, 5	249	+ 39	5	1,260	+ 176	6½	+2
Middleton.. ..	,, 5	247	+ 48	5	1,226	+ 68	8½	—
Oldham—Ashton	,, 5	497	— 2	5	2,494	— 162	8	—
Potteries	,, 5	1,668	+186	5	8,106	+ 411	28½	—
Southport	,, 5	259	+ 58	5	1,224	+ 145	5½	—
South Staffs. ..	,, 5	701	+ 16	5	3,649	+ 261	21½	—
Swansea	,, 5	448	—	5	2,320	+ 39	5½	—
Wolverhampton..	,, 5	322	— 12	5	1,631	— 54	10½	+3
Yorks. Wool Dist.	,, 5	483	—	5	2,515	—	6	—
Miscellaneous ..	,, 5	1,208	—	5	6,137	—	—	—
Burnley	,, 13	589	+221	—	—	—	7½	—
Burton-on-Trent ..	,, 14	302	—	28	9,712	—	8½	—
Cardiff	,, 6	1,847	+299	—	87,843	+22,190	1	—
Chatham & District	,, 11	526	+115	6	3,020	+ 666	8·53	—

* Compared with the corresponding period of 1903.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Cork	Feb. 11	377	— 22	6	2,368	+ 31	9	—
Dover	,, 13	170	— 1	6	1,063	— 50	3	—
Dublin	,, 12	4,374	— 45	7	26,824	+ 813	47	+ ½
East Ham	,, 13	598	+ 84	—	30,267	+ 8,182	5	+ ½
Glasgow	,, 13	12,685	+ 55	37	504,581	+52,105	69½	+7½
Halifax (2 weeks) ..	,, 10	2,195	+121	45	60,181	+ 6,303	31½	+1½
Huddersfield ..	,, 13	1,078	+ 34	—	—	—	—	—
Hull	,, 13	2,039	+324	46	87,700	+ 6,764	18	+2
Ilkeston	,, 10	127	—	—	—	—	3½	—
Ipswich	,, 13	332	—	—	3,556	—	9	—
Isle of Thanet ..	,, 13	229	— 26	6	1,2•0	— 83	10½	—
Leeds	,, 13	4,902	+ 50	—	250,099	+15,377	41	—
Liverpool	,, 6	9,648	+ 520	6	57,388	+ 2,684	103	—
London C. C. ..	,, 6	9,373	+1330	44½	489,356	+77,856	39½	—
Manchester	,, 13	10,556	+2247	—	131,030	+278,625	72	—
Newcastle	,, 13	3,478	+418	—	—	—	17	—
Portsmouth	,, 13	1,873	+168	—	79,360	+ 5,020	14½	—
Salford	,, 15	3,568	+693	—	175,176	+48,807	30	—
Sheffield	,, 14	4,160	+ 82	46½	210,224	+17,507	32½	+4½
Southampton	—	—	—	—	—	—	16½	—
Southend-on-Sea ..	,, 10	205	+ 18	45	14,181	+ 2,182	8	—
Sunderland	,, 14	1,078	+ 67	46	55,444	+ 2,608	20	+3
Tyneside	,, 10	280	+ 44	6	1,601	+ 362	8·9	+ ·43
Wolverhampton ..	,, 14	339	— 63	—	—	—	5½	—
Cen. London Rly...	,, 13	7,095	+168	7	48,883	+ 242	6	—
City & S. Lon. Rly.	,, 7	3,239	+ 26	6	19,288	— 917	6½	—
Dublin—Lucan Rly.	,, 14	93	+ 3	7	601	+ 36	6½	—
L'pool Overh'd Rly.	,, 14	1,481	— 1	7	10,745	+ 354	6½	—
Mersey Railway ..	,, 13	1,372	+383	6	8,585	+ 2,248	4½	—

INSTITUTION OF ELECTRICAL ENGINEERS.

THE STEAM TURBINE.

By William Chilton.

(*Abstract of Paper read at Manchester, February 2nd*, 1904.)

(*Concluded from page* 284.)

The members of this Institution no doubt remember the recent correspondence in the technical Press respecting the merits of the two types of prime movers. Those who took sides in this controversy might, perhaps, be suspected of partiality towards the motor whose merits they were advocating, but we, as engineers and seekers after truth, will endeavour to compare the merits of the rival claimants for our favours without bias.

With regard to turbines and reciprocating engines, at present there is room for both. For the smaller units and when working non-condensing the reciprocator has undoubtedly the advantage, but from 400 to 500 kw. output and upwards, and when working condensing with a good vacuum that can be obtained at a small cost, the advantages are often on the side of the turbine. It is for the engineer to study each case on its merits, and then decide which plant he will use.

The author, and the firm he represents—the Brush Electrical Engineering Co., Ltd.—hold no brief for either machine. They are designers and manufacturers of both, and can, therefore, impartially consider their respective merits. It may be well here to state that the Brush Electrical Engineering Co., Ltd., have for some time taken up the manufacture of the Parsons turbine under licence from Messrs. C. A. Parsons & Co.

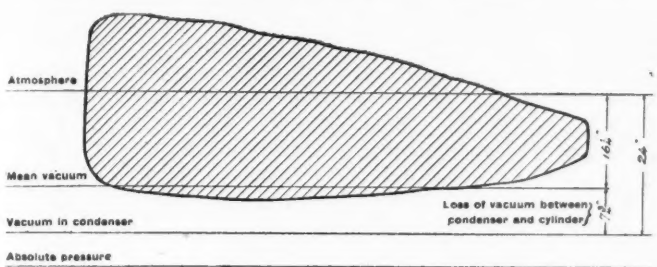


Fig. 4.—Maximum Vacuum in Cylinder, 19 in.

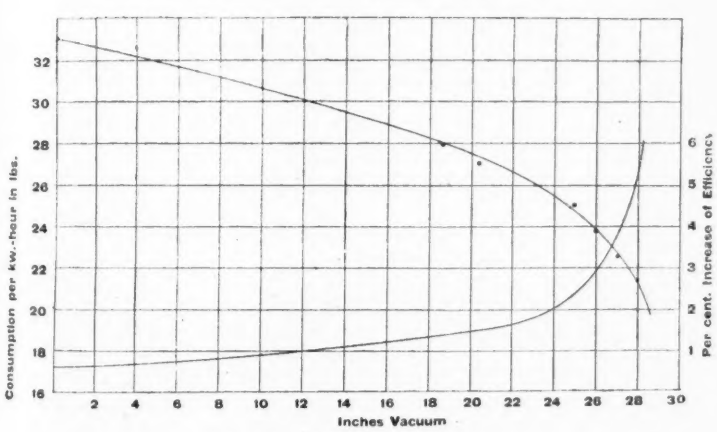


Fig. 5.

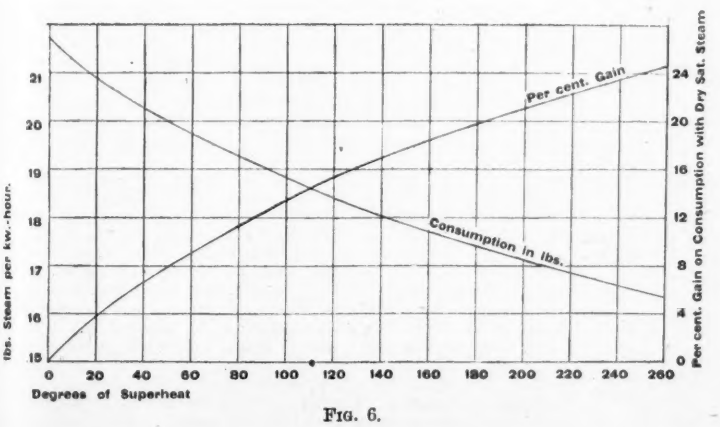


Fig. 6.

It is a frequent complaint that comparisons of efficiencies are made between turbines working with very high and reciprocators with lower vacua.

It is, however, well known that the steam efficiency of the ordinary engine only increases to a small extent when the vacuum rises beyond 25 in. of mercury, and this is more marked in high speed than in slow speed engines.

The reason is obvious, as a consideration of the following table will show.

The volumes are here given of 1 lb. of saturated steam at atmospheric pressure and also at vacua, varying from 25 in. to 29 in. of mercury; in the top line are given the actual volumes in cubic feet; in the lower line, for the sake of more easy comparison, the volume at atmospheric pressure is given as unity; the others in multiples of unity.

Vacuum in inches of mercury	0	25	26	27	28	29
Volume of 1 lb. of saturated steam in cubic feet	26·36	145	177·6	237	347·6	709
Comparative volume — volume at 0″ vacuum = 1	1	5·52	6·75	9	13·3	27

The table shows how greatly the volumes increase with each inch drop in the absolute pressure beyond that due to 25 in. of mercury, and how great is the volume to be dealt with when the vacuum reaches 28 in. or 29 in. of mercury.

Now, it is not that reciprocating engines, as such, would not give better results at high vacua than at low, but because the low pressure cylinder, valves, passages, and exhaust pipes would have to be made of such inordinate sizes to deal with the enormous volumes at low pressures, that 25 in. vacuum is generally found to be about the economical limit.

In high speed reciprocating work, too, it is mostly found necessary to place the condenser at some distance from the engines. In turbine plant, on the other hand, it is convenient and also economical in first cost to place the condenser immediately below the turbine; the exhaust pipe is only a few feet in length, and can be from four to six times the area of that of a reciprocator of the same output, the drop in pressure between condenser and cylinder is in consequence very considerably less. Again, steam used in a turbine can easily be expanded 70 to 100 times, and delivered to exhaust at exhaust pressure, whereas in the reciprocator it is not convenient to expand much below atmospheric pressure, and there is often a large drop from the pressure at release to that of exhaust. In the turbine a drop in pressure between condenser and cylinder of $\frac{1}{2}$ in. to $\frac{3}{4}$ in. of mercury may be expected, but in reciprocating sets a difference of 5 in. between the mean back pressure in the cylinder and the absolute pressure in the condenser is quite common. It follows that in the turbine the gain in economy per inch increase of vacuum above 25 in. is much more than in the reciprocator, and for this reason it is advantageous to incur the slight extra cost of condensing plant capable of giving the high vacuum necessary for high economy. The difference in vacuum in the condensers themselves, however, in the two cases, for the reasons already stated, is not so great.

If we require a mean vacuum during exhaust of 23 in. inside the L.P. cylinder of a high-speed engine, it will be unwise to design the condenser to give less than 27 in. vacuum, whereas, in a turbine set, 27 in. to 27·5 in. vacuum could be expected in the cylinder with 28 in. vacuum in condenser.

Fig. 4 shows the mean back pressure line in the L.P. cylinder of a triple-expansion high-speed engine; the vacuum in the condenser is also given, and the barometric pressure of 30 in. of mercury is assumed. The example is taken from a high-class high-speed engine of over 450-kw. output, and of very recent date, and it will be seen that the loss referred to is, in this case, 7½ in.

Fig. 5 shows two curves, giving approximately the saving which may be effected per each 1 in. increase of vacuum from 0 in. up to 28 in. vacuum. The upper curve gives the actual consumptions at full load, and the lower curve the percentage saving. The rapid rise of the lower curve well illustrates how much the turbine gains by working with a good vacuum.

The dots on or near the curves show measured consumptions obtained at the vacua indicated below.

The following tabular comparison of the condensing plants

required for reciprocating and turbine sets of 500-KW. output will be of interest:—

Particulars.	Reciprocator.	Turbine.
Consumption of steam per KW-hour, lbs. ...	25	22·5
Steam to be condensed per hour, lbs.... ...	12,500	11,250
Tube surface in square feet	1,050	1,540
Vacuum in condenser, in. of mercury ...	26·5	28
Air pump cap., cb. ft. per min.	125	150
B.H.P. to drive air pump	3·3	3·85
Circulating water, gals. per min.	730	830
B.H.P. to drive circulating pump	5·5	6·3
Temperature circulating water inlet	65° F.	65° F.
„ „ „ outlet... ...	95° F.	90° F.
Mean temperature in condenser	119° F.	100° F.
Cost prime mover and generator	£3,250	£3,250
„ condensing plant	£556	£659
Total cost	£3,806	£3,909

Extra cost of turbo plant over reciprocating plant, about 2·7 per cent., but inasmuch as the engine will probably be fitted with an oil filter for extracting the oil from the exhaust steam, the cost of the turbo plant will probably not be more than the other.

The turbine requires no holding-down bolts, the foundations and buildings are less costly, and crane capacity required is less. Add to this that no lubricating oil is necessary for cylinder lubrication, and the turbine comes out very favourably in comparison with the reciprocating engine.

With regard to superheat, both types of engines derive great benefit from its use, but for different reasons.

One source of great loss in reciprocating engines using saturated steam is initial condensation, and this loss can be reduced by superheating.

In the turbine there is little or no initial condensation, as the metal surfaces with which the steam comes into contact do not change in temperature on steady load. On the other hand, water, which may come over with the steam, in addition to that formed by condensation due to work done, produces in its passage through the turbine a large amount of viscous friction, and reduces the mechanical efficiency. Superheating the steam reduces this loss.

The advantage which each gains by superheating is about the same, and the gain for each stage of 50° F. of superheat is approximately as follows:—

First	50° of superheat	8 per cent.
Second	„ „	6 „
Third	„ „	5
Fourth	„ „	4 „

But the use of superheat introduces certain difficulties in both forms of generators, which, however, promise to be less in the turbine than in the reciprocator. In the former the clearances between the blade tips and the surfaces of the cylinder and the rotor have to be increased; in the latter the valve and piston clearances. In the former there are no rubbing surfaces subject to the action of dry steam of high temperature, and no lubricant is used; in the latter a short run without the use of high priced oil would play havoc with the engine.

The curves in fig. 6 show the increased efficiency to be expected by superheating the steam; the rising curve gives the percentage gain for various degrees of superheat on the consumption with no superheat, the falling curve gives the actual consumption in pounds per KW.-hour for various degrees of superheat.

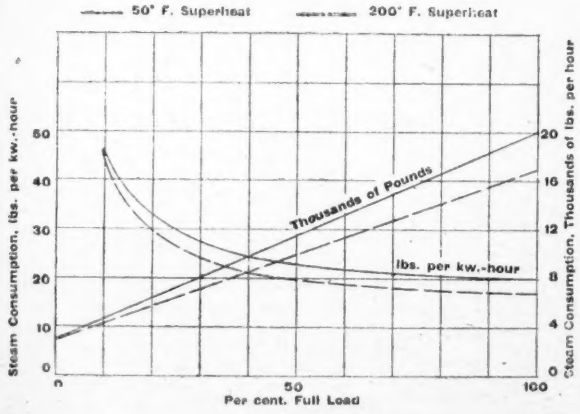


FIG. 7.

In diagram fig. 7 are given the consumptions that can be guaranteed with steam of 150 lbs. per sq. in. pressure and superheat of 50° F. and of 200° F., and vacuum of 28 in. of mercury.

The table in fig. 8 gives comparative weights of slow-speed engines, high-speed engines, and of turbines.

In conclusion, the author tenders his best thanks to Messrs. the Brush Electrical Engineering Co. for the great help they have given him in the preparation of the diagrams, and to Messrs. C. A. Parsons and Co., and to Mr. J. H. Barker, for the data and information with which they have supplied him.

FIG. 8.

Kilowatts output.	Weight of slow-speed engine.	Ditto: weight of fly-wheel.	Weight of high-speed engine.	Weight of turbine.
500	140	27	30	9
750	190	43	45	12
1,000	250	59	60	14
1,500	380	88	90	21
1,800	450	100	110	23
2,000	530	120	120	25
2,500	700	145	155	27
3,000	—	—	—	32
3,500	—	—	—	35
5,000	—	—	—	42

Comparative weights in tons.

Mr. E. W. COWAN (chairman) announced that the formation of a students' section for Manchester is now an accomplished fact, and that the students have their own committee, composed entirely of their own members and a vice-chairman; also, at present, there is the prospect of at least 100 students joining, and it is hoped that before long there will be many more. He then referred to the death of Mr. McMillan, the secretary of the parent Institution, and and after speaking in terms of high praise of the great services rendered by Mr. McMillan to the Institution, proposed the following resolution, to which all present gave their assent. The resolution was worded as follows:—

"The members of the Manchester Section of the Institution of Electrical Engineers present at this meeting, learn with great regret of the death of Mr. McMillan, secretary of the Institution; and, remembering the tact, energy and unfailing courtesy with which he carried out the negotiations relating to the inauguration of the Manchester Section, they wish to record their sense of the loss which the Institution has suffered by his death; and they wish, also, to express their deep sympathy with Mrs. McMillan in the great loss which she has sustained."

DISCUSSION.

The CHAIRMAN thought the importance of the subject of the paper was second to none. He also considered that the discussion should be of such a nature as to come under one of the following headings:—

1. Various types of turbines.
2. Comparison of turbines and reciprocating engines.
3. The care and working of steam turbines.

Mr. LOWDEN was glad to note that the author of the paper laid stress on the relative advantages of turbines and reciprocating engines. In turbines, the greatest drawback is the fouling of the blades. In earlier days, there was trouble with this type of generator, mainly, for the following reasons:—

1. Bad design of cylinder and spindles; the passages were *cast* in the cylinders, and these got distorted by superheat.
2. Superheat used in cases where the turbines were not designed with a view of its being employed at all.
3. Sinking of foundations.
4. Failure of oil supply.

He had heard of no case of blades stripping recently. Oil is now forced into bearings under pressure, and a measurement in one case of the electrical resistance between a bearing and the spindle revolving in it gave 1 megohm as the result, showing that the spindle was completely surrounded by oil.

Mr. WHYSALL gave some particulars of two 1,800-KW. sets at the Manchester Corporation generating stations, one being driven by a steam turbine, the other by a slow-speed reciprocating engine. Comparing the weights, he said that that of one turbine was 85 tons, which was equal to about 0·7 of the weight of the fly-wheel only of the reciprocator. The space occupied by the turbine was 47 ft. 6 in. × 8 ft. 6 in. × a total height of 11 ft., the average height being about 9 ft. A vacuum of 20 in. to 23 in. is employed, steam pressure 125 lbs. (saturated). As regards oil consumption, the turbine was very satisfactory, the cost working out to 0·0018d. per KW. as compared with 0·006d. per KW. for the reciprocator. A curious point was mentioned by this speaker in connection with the brushes on the two generators driven respectively by the turbine and the slow-speed engine. In the former case, the generator was a high-speed one, using copper brushes, and these wore down very rapidly, and involved a very considerable expense per annum, whereas the slow-speed generator had carbon brushes, and cost of these per annum was practically negligible. A test of the turbine had shown very good results. The guarantee was 20 lbs. steam (125 lbs. pressure) at full load and 23 lbs. at half load. The test gave 19·5 lbs. per KW at full load with a vacuum of 26·5 in., which was ½ in. less than the specification. The reciprocating engine with 156 lbs. steam and 27·4 in. vacuum gave 19·83 lbs. per KW. as the result of test.

Mr. BARKER said many people desire to know how much the blades of a turbine are cut by the steam. It was, he declared, impossible for the steam to cut them at all, as the difference of pressure between successive rows of blades is not more than ½ lb. In 10 years he had never seen any signs of any cutting. The best metal to use for the blades, with superheat, is undoubtedly copper. This metal can be used up to 800° F. superheat all right.

Mr. ANDREWS told his experiences of a steam turbine in use at Hastings, and stated that blades *do* rip out sometimes in spite of what the makers and other interested people may say. It was, however, a fact that blades might be stripped and the attendant not know it. This actually happened at Hastings; it was only found

out by the increased steam consumption. He had also to say in the turbine's favour that, after the above accident, all the blades were put in, and the turbine was running again in 36 hours, and this in spite of the fact that the makers had to be telegraphed to, to send a fitter down with a new set of blades. Referring to steam consumption, he remarked that at the time the turbine was put down the tests gave a result better than the guarantee, which was 21 lbs. steam per KW. for a 500-KW. turbine. Later tests showed results quite as good. He considered reciprocating engines were best where condensing arrangements were not good. As showing the importance to a turbine of high vacuum, Mr. Andrews said that a 500-KW. turbine without vacuum would only take a load of 350 KW., but with 27 in. vacuum it would take 550 KW.

Mr. WELLS thought the time had hardly arrived yet for reciprocating engines to take a back seat. The table in the paper showing 25 lbs. steam as the consumption of a 500-KW. reciprocating engine was, he thought, too high; it should be 22 lbs. at the most.

Mr. COOPER, referring to Mr. Whysall's remarks as to copper brushes being an expensive item, stated that a generator (driven by a turbine) having carbon brushes is now made by one firm satisfactorily. He had known a case of blades stripping; these, however, took a fortnight to repair, and the turbine could not be run in the meantime.

Two or three other gentlemen also spoke, and Mr. CHILTON replied briefly.

THREE-PHASE WORKING, WITH SPECIAL REFERENCE TO THE DUBLIN SYSTEM.

By WM. BREW.

(*Abstract of Paper read at Dublin, January 14th, 1904.*)

(*Concluded from page 282.*)

THE smaller sizes of Dublin sub-stations are connected with the central distributing station at Fleet Street by a ·04 sq. in. three-core sub-feeder and spare. This cable, we have seen, possesses a Y capacity of ·298 microfarad per mile. In the case of a sub-station taking a magnetising current of 0·27 ampere per phase, and coupled to a length of one mile of this cable, we have L = 34 henrys and K = ·298 × 10^{-6} farads. The natural frequency of oscillation, f, of this circuit is, therefore,

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{L\,K}} = 50,$$

which corresponds to the frequency of the supply.

The above conditions are very nearly attained with three 40-KW. transformers coupled in delta in one of the Dublin sub-stations. The feeder to this sub-station was switched on and off on several occasions, however, without any visible indication of resonance. It was considered of interest to examine this circuit by means of an oscillograph.

Three-phase Distribution.—With three-phase distribution we have the choice between three-core or four-core distributors. We are also at liberty to vary the size of the fourth wire of the four-core cable.

TABLE IV.—COMPARISON OF FOUR-CORE AND THREE-CORE DISTRIBUTORS WITH 200 VOLTS AT CONSUMERS' TERMINALS AND CR DROP OF 4 PER CENT. PER QUARTER MILE.

Description of Distributor.			
Four-core. Consumers connected between each phase and neutral.		Three-core. Consumers connected between each phase.	
Section of each conductor in square inches.			
0·1	·05	·1	·08
Effective pressure between conductors in volts.			
346	346	200	200
Maximum instantaneous pressure between conductors.			
488	488	283	283
Effective pressure between conductors and neutral or earth.			
200	200	115·5	115·5
Maximum instantaneous pressure between any conductor and earth.			
283	283	163	163
Drop in volts per core per quarter mile = 4 per cent. of consumers pressure.			
8	8	4·6	4·6
Current density per core in amperes per square inch to give 4 per cent. drop.			
726	726	421	421
Number of kilowatts transmitted, with 4 per cent. drop per quarter mile.			
43·5	21·7	14·6	7·3
Cost of cable in £ per quarter mile laid and jointed in troughing = C.			
£181	£124	£150	£106
Capital outlay in £ per kilowatt transmitted quarter mile.			
£4 17s.	£5 72	£10 3s.	£14 5s.

Table IV. illustrates the principal points by which distribution by three-core and four-core cables would differ in practice. As regards the size of the fourth or neutral wire to be adopted we might follow the practice of three-wire distribution and reduce the section of this to some extent. There are, however, reasons which probably justify retaining this conductor of the same size. For instance: (*a*) one phase being interrupted, the resultant full-load current of the other two phases will combine to form full-load current on a neutral of the same section as the other conductors, and one third only of the consumers will be affected; (*b*) similarly, two phases being interrupted, the neutral will then act as a return for the third phase of equal section, with a slightly increased drop in pressure; (*c*) the increase in the total cost of the cable with the fourth core added of same section as the other three cores only amounts to 20·6 per cent. and 17 per cent. respectively in the case of the ·1 and ·05 distributors considered for 30 per cent. increase in copper.

The principal points in favour of the four-core cable system which has been adopted in Dublin are: (1) greater amount of energy transmitted for given capital cost, the system acting in a manner similar to an ordinary three-wire distribution; (2) less variation in pressure due to want of balance amongst consumers; (3) less inconvenience to consumers in the event of any phases being interrupted—our working experience in Dublin is that considerable weight should be attached to this point. On the other hand, against the four-core cable we have: (1) greater pressure between conductors, tending to break down the insulation of the cable and street boxes; (2) extra expense as regards fittings in house service boxes; disconnecting boxes, &c.

Public Lighting.—With a three-phase system of supply, as with other systems, special transforming or other generating plant will generally be required to deal with public lighting by means of arc lamps. If we are dealing with a large area, the cost of a spherical candle-power at the street lamps will usually be least with direct current open-type arcs under normal working conditions.

In Dublin the circuits are arranged with 21 lamps in series with a terminal pressure of 1,100 volts. The circuits are supplied by two direct-current generators in series, with their middle point earthed through an indicating device, the two generators being driven from an asynchronous motor on the same shaft. The maximum pressure to earth at any one lamp will, therefore, never exceed 550 volts, and will only reach this figure at two lamps on each circuit. Three of these three-phase motor-generators of 210 B H.P., are installed, supplying 500 double-carbon open-type arc lamps.

Three-Phase Motor-Generators.—The impedance of one of these machines was measured. In making the observations, the motor was held stationary and the slip-rings short-circuited. Observations were then made of the current in each phase of the stator for various applied voltages. It is important to notice that the short-circuit current at 5,000 volts amounts to about five times the full-load current of 20 amperes. With a machine of this class, if copper fuses in oil baths of the Ferranti type be employed on the extra high-tension side, it will be necessary to examine them at frequent intervals, as the copper will have to be run hot at full load if the fuse is really to be of service in the event of a short-circuit on one of the generators. A curious effect has been observed with these machines. With one of the 500-KW. generators coupled to two trunk mains supplying a motor-generator at full load during the daytime with practically no other load on, a slight surge has been observed having a period of about twice that of the engine speed. The same load divided amongst two motor-generators had no effect. Again, with two motor-generators fully loaded the same conditions did not produce any appreciable effect. It would appear, therefore, that the motor-generator must be working at a certain power factor to produce this result. The writer is further investigating this matter. These machines were found of considerable value as regards their balancing effect on the pressures on the Dublin network when, on starting the new system of supply, the three phases were unavoidably somewhat out of balance for some days.

In concluding these short notes, the writer desires to express his thanks to Mr. Robert Hammond for permission to bring the subject before you.

ROYAL COMMISSION ON LONDON TRAFFIC.

AT the sitting of the Royal Commission on London Traffic on Friday, under the chairmanship of Sir David Barbour, further evidence by Mr. J. E. Waller was given.

WITNESS said he believed the only satisfactory way to deal with the tramway legislative problem, whether applied to London or the whole of the country, was the creation of a special Tramway or Street Traffic Board, probably forming a Government Department.

Mr. CHARLES E. BAKER, hon. secretary of the Urban District Councils' Associations, said he had ascertained the views of the Urban District Councils around London, and they generally concurred in the suggestion that there should be a new and independent tribunal to deal comprehensively with the question of traffic in and out of London. There should be power of appeal to either Parliament or the Board of Trade. The Board should have power to make an inquiry into the financial position of promoters.

Mr. C. G. MOTT, the chairman of the City and South London Railway Co., was then called. He said that he had given great consideration to the question of locomotion in London. He considered that serious relief from the future growing traffic of the metropolis would only be looked for in the construction of deep-level underground electric railways. If those railways were to afford the maximum of convenience to the public, they ought to be so arranged as to become one complete network of communication, so that a passenger descending at one station might be able, by changing from the platform of one railway to those of another, to proceed to any part of the metropolis without the necessity of coming again to the surface until he had arrived at his destination. If that were done, it would greatly relieve the traffic of the streets. At the present time all such railways had to be constructed under the lines of the existing streets, in order to avoid payment for the

use of subsoil, but in many instances it would greatly conduce to the public advantage if the railways could be constructed in more direct lines under private property. A Joint Parliamentary Committee recognised that some years ago, and upon their recommendation, powers had since been granted authorising the railways in those cases to take an easement only, instead of being compelled to purchase the property on the surface. Considering the great depth at which those railways were constructed, the value of that easement was exceedingly small, but the number of separate properties under which the line in such a case would pass was so great, that the legal expenses involved in settling the amount to be paid and obtaining a separate conveyance in each case, were such that at present the passing under private properties for any distance was not practicable. As the value of the subsoil at that depth was the same all over the metropolis, he thought Parliament might fix some uniform sum to be paid for it, and so avoid the enormous legal powers involved. Witness proceeded to deal with the passing of the company's first Act and the subsequent Bills authorising extensions, and said when the whole of these extensions were completed the length of the line would be 12¼ miles. When they took over the powers of the City and Brixton Railway, they intended to proceed with the construction of that line at an early date, but owing to the effects of the L.C.C. tram competition, it was at present impossible to raise the capital for the construction. They were, however, making arrangements to proceed at an early date with the construction of the extension to King's Cross and Euston, and he believed this would relieve the streets. After 40 years' experience of Bills in Parliament, he was of opinion that the present mode of procedure was, on the whole, the best. As regarded London and 20 miles around the jurisdiction of the Light Railways Commission should be withdrawn, and no tramway allowed unless sanctioned by Parliament, so as to get a complete unity of action as regards all traffic carried on rails within the Metropolitan area. The responsibility of Parliament should be in no way lessened, but a permanent committee appointed by the Home Office, Local Government Board, and the Board of Trade, might sit frequently and report to Parliament at the commencement of each session on all Bills affecting railways in the Metropolitan area, and such reports should be referred to the various committees to whom the Bills were sent.

Mr. A. E. Gathorne Hardy, chairman of the East London Railway, suggested that in any scheme or measures for the intercommunication of railways and tramways, consideration should be given to the East London Railway, which was established in 1865, to connect, by means of the Thames Tunnel, the railways north and south of the Thames. The line was leased to the Metropolitan, Metropolitan District, London and Brighton, South-Eastern, Great Eastern, and London and Chatham Railways, and was worked by a Joint Committee. There had been little increase in the passenger traffic of late years. In 1902 the Metropolitan and Metropolitan District Railways inserted clauses in their Bills to electrify the East London Line, but the other parties to the lease did not see their way to participate in the cost, although they were agreeable to the Metropolitan and District Cos. carrying out the work. As a result of this the clauses were withdrawn. He did not see how the Metropolitan and District Railways were to give an adequate service over the East London line unless it was electrified; the result would be a dislocation of the service, which would cause the greatest possible inconvenience. He submitted that if the existing lessees failed to make efficient use of the line, any new company willing to do so should be permitted to participate, on undertaking its share of the obligations.

The Commission adjourned.

It is announced that the Commission has nominated Sir John Wolfe Barry, one of the Royal Commissioners, Sir Benjamin Baker, and Mr. W. Barclay Parsons, consulting engineer to the Board of Rapid Transit Railroad Commissioners of New York, to advise the Commission on certain important technical questions connected with locomotion and transport in London. The Commissioners have taken a mass of evidence upon proposals which it is suggested would alleviate existing conditions of traffic and afford further facilities, and the advisers to the Commission will report upon the engineering and other technical considerations involved in these proposals. It will not be the duty of technical advisers to the Commission to make any report upon specific schemes which have formed the subject of applications to Parliament.

ELECTRO-CAPILLARITY.

The "double layer" hypothesis now forms an important part in the explanation of electrical phenomena. It has recently been applied by C. Christiansen to some interesting cases of electro-capillarity. He has examined (1) the movements and changes of form of a globule of mercury in an electrolyte, and (2) of falling drops of mercury in an electrolyte. His results are described in the *Annalen der Physik*, pp. 1072—1079, for November, 1903. The movements of such a globule in an electrolyte were shown by Rollo Appleyard at the Physical Society, March 26th, 1897 (*c.f.*, *Phil. Mag.*, May, 1897, "Liquid Coherers and Mobile Conductors"); and were dealt with by Lord Rayleigh, at the Royal Institution, April 10th, 1897 (*c.f.*, *Electrical Engineer*, Vol. xix., April 16th, 1897). Christiansen has, however, considerably extended the observations, all of which come into the category of the Lippman effect. It is proposed here to give an account of Christiansen's work as described in his paper, *l c.*

Globules at Rest.

Deformations.—Into a glass dish 10 × 4·5 × 4 cms., dip two platinum plates B B, connected to copper wires C C, and to the binding screws D D, as shown in fig. 1. At the

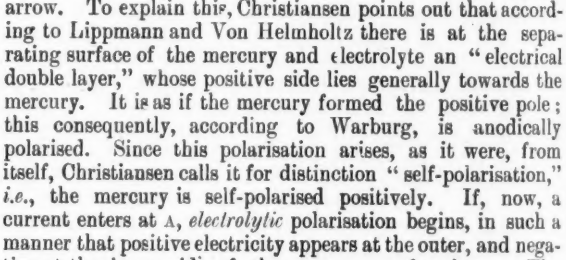


Fig. 1.

bottom of the dish is an ordinary watch-glass, E, containing a globule of mercury. Into the dish is poured 45 cc. of a 1 per cent. solution (normal) of KNO_3, as an electrolyte. When there is no current, the globule as seen from above is now circular, and is, say, 11 mm. diameter. With a current of 0·010 ampere, the globule takes the form represented by fig. 3, where the direction of the current is indicated by the arrow. To explain this, Christiansen points out that according to Lippmann and Von Helmholtz there is at the separating surface of the mercury and electrolyte an "electrical double layer," whose positive side lies generally towards the mercury. It is as if the mercury formed the positive pole; this consequently, according to Warburg, is anodically polarised. Since this polarisation arises, as it were, from itself, Christiansen calls it for distinction "self-polarisation," *i.e.*, the mercury is self-polarised positively. If, now, a current enters at A, *electrolytic* polarisation begins, in such a manner that positive electricity appears at the outer, and negative at the inner side of the mercury surface-layer. The

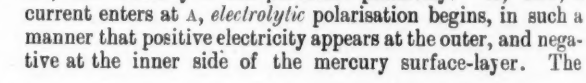


Fig. 2. Fig. 3. Fig. 4. Fig. 5. Fig. 6. Fig. 7.

result is that the self-polarisation is diminished, the surface tension at A being thereby increased. At B, conversely, the surface-tension is lessened. Hence, mercury flows from B towards A at the surface, and from A towards B within the globule. While mercury flows thus from B towards A at the surface, the limiting layer of electrolyte is broken down, and is carried along in a direction opposed to the electric current. This can be observed by watching the movement of dust particles in the liquid. Meanwhile the globule of mercury itself moves, in accordance with the law of equality of action and reaction, towards the negative pole.

Now let the current increase to 0·020 ampere. There then forms at C C (fig. 4) a slight enlargement K. In this case the electrolytic polarisation at the point A has become greater than the self-polarisation. But at C C both are equal, so that they there neutralise one another. Consequently the surface-tension at C C is a maximum. The result is that mercury flows from both A and B towards C C, and the opposing streams form the observed enlargement.

At 0·030 ampere, the globule takes the form shown in fig. 5. There is an inflection between A and B, upon which the enlargement C C clearly appears. At 0·033 ampere the globule is perceptibly lengthened (fig. 6) and has a decidedly projecting neck. The surface-tension is still a maximum at C C, and the globule is there compressed, as if it were bound with an elastic ligament, tending to divide the globule; but this tendency is in part resisted by the surface movements. With increased current the globule is divided, as shown in fig. 7, into a small drop A and a greater drop B, which often retreat from one another with considerable force.

Translation of Globules.—In order to form an estimate of the magnitude of the forces, Christiansen modified the experi-

ment. Fig. 8 shows a wooden scale, A B, 50 cms. long. Upon this is fastened the bent glass tube C, the internal diameter of which is 6 mm. The tube C is provided with

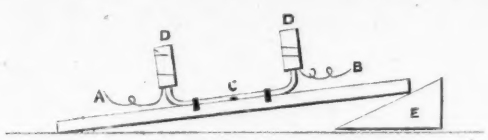


Fig. 8.

wider tubes, D D, one at each end, to contain the electrolyte. The level of the tube C can be varied by means of the wedge E. A mercury globule 0·5 gramme in weight was given a position at the middle of the tube in an electrolyte of 10 per cent. normal solution of KNO_3. It was found that the globule was in equilibrium for 0·0035 ampere when B was 1·6 cm. higher level than A.

It is well known that in a solution of potassic cyanide the self-polarisation of mercury is negative. With this electrolyte, the globule moves therefore towards the positive electrode. In a 10 per cent. neutral solution of potassic cyanide the globule was in equilibrium for 0·0080 ampere, when A was 1·6 cm. *higher* level than B. Note the reversal. Again, in a 10 per cent. normal solution of sodic hydrate the moving force is very slight; in this electrolyte, if A B is horizontal, with 0·011 ampere, the globule moves slowly towards the negative pole. If the current is increased, the moving force becomes at first less; it then changes as to direction, and at 0·015 ampere the globule travels towards the positive pole. At the same time it becomes elongated. At 0·018 ampere it divides, and both drops move towards the positive pole.

The explanation of this wonderful phenomenon lies in the fact that the self-polarisation of mercury in the solution is very small. The globule moves first towards the positive pole. If now, owing to the rotation of the globule, the self-polarisation should become zero, forces come into play tending to move the globule towards the opposite side. The condition which preponderates is determined by circumstances about which it is difficult to make a concise assertion. Exact measurements of the forces cannot be made by this method. It appears, however, that, in a dilute solution of potassic nitrate, which gives a high degree of self-polarisation, the force is at first proportional to the current. It increases with the magnitude of the globule, but only within certain limits.

Chemical Effects.—Referring to fig. 5, let it be supposed that the electrolyte is nitric acid. Under ordinary conditions, hydrogen ions then separate out upon A C, and NO_3 ions upon B C. On account of the variable surface tension, these ions move towards C C, when they combine to form again HNO_3. This combination does not, however, always take place completely. To begin with, there are very often, in the case of sulphuric or of nitric acid, small air bubbles at C C; these sometimes remain quiescent, sometimes they are unsteady, generally they increase in size, and at last are set free. Similar bubbles may be observed when a solution of certain ammonium salts are used. The separation and recombination of the ions can be very well seen when a little phenolphtalein is added to a solution of potassic nitrate. There then forms a red girdle at C C, which is ultimately driven off by the movements of the electrolyte, so that it gradually loses its colour, and the ions recombine.

Falling Globules.

Pure Mercury.—In these experiments Christiansen uses a glass vessel, A B (fig. 9), 8 cm. high, 5·5 cm. in breadth, and 1 cm. wide. Two platinum plates E and F, 1 cm. wide, serve as electrodes. D is a very narrow glass tube from which mercury falls as drops. The diameter of the drops in his experiment was about 1 mm. G H is a mm. scale, attached to the outside of the vessel. The perpendicular distance from the point D to the scale was 5 cms. At the bottom of the vessel is an aperture, through which the mercury can be drawn off and conveyed away by the tube C. If the vessel is filled with dilute sulphuric acid, the drops fall plumb, but when an electric current passes from F towards E, the drops take a course towards the negative pole. The point on the scale at which the drops now fall is read off, and denoted by a divisions. The current is then reversed, and the drops then move towards F; the corresponding scale-reading is denoted by b. The difference $b - a = u$ cms. is called the "double deflection." As an example, in Table I., the results are given for an electrolyte of zinc sulphate solution.

TABLE I.

Amperes.	u = Double deflection in 1/2 Zn SO_4 (normal).				
	1/1	1/10	$1/10^2$	$1/10^3$	$1/10^4$
0·005	3	7	9	11	10
0·010	6	13	18	20	—
0·015	8	19	26	28	—
0·020	10	25	33	—	—
0·030	15	34	—	—	—
0·040	20	—	—	—	—

It is seen that u is approximately proportional to the current; with diminishing concentrations the values of u approach to a limit. Experiments with different electrolytes give the results shown in Table II, where the current is throughout maintained at 0·02 ampere.

TABLE II.

Electrolyte (normal).	1/1	1/10	$1/10^2$	$1/10^3$
1/2 Cu SO_4 ...	12	24	30 5	—
1/2 Cu $(NO_3)_2$ ...	5	20	35	—
1/2 K_2 SO_4 ...	8	24	34	—
K NO_3	3	13	34	—
H NO_3	—	6	24	36
1/2 H_2 SO_4 ...	2	8	24·5	36
H Cl	2·5	6 5	21 5	29
KOH	—	6	27	—

These results also show that, in proportion as the solutions are diluted, u approaches to a limit, and it may perhaps, be assumed that this is true up to the point of infinite dilution. The movements in these latter experiments are analogous to those observed with the stationary globule. In contact with the electrolyte, the self-polarisation of the globules gradually develops, and under the influence of the electric current movements become apparent at the surface of the globules. If the self-polarisation developed instan-

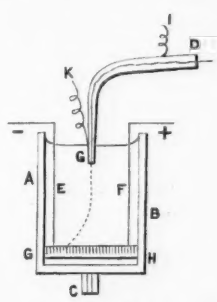


Fig. 9.

taneously, the deflecting force acting upon the jet of mercury globules falling in the electrolyte (fig. 9) would be constant, and the path of the globules would be a right line. In

TABLE III.—Double Deflection in Potassic Cyanide Solution.

Amperes.	1/1	1/10	1/100	1/300	1/600	1/1000
0·005	—	—	—	—	—	+13
0 010	—	—	—	—	—	+24
0·020	−1	−1·5	−3	—	+22	—
0·040	−2	−3	−19	−21	—	—
0 080	−4	−8	−40	—	—	—
0·150	−8	−20	—	—	—	—

reality, a certain interval of time is necessary; the path is, consequently, curved, as shown in fig. 9.

The experiments with potassic cyanide are especially

interesting; here it would be expected that the globules would fall towards the positive pole. The results are tabulated in Table III., where the deflections are marked + or −, according to whether the globules tend towards the negative or positive pole. With small electric currents, and in very weak solutions, the drops fall towards the negative electrode; according to Christiansen, the self-polarisation is then negative (positive ?), as with most electrolytes. With concentrated solutions, the direction of the drops is reversed, because the self-polarisation is then negative. This method of explanation does not, however, account for all the phenomena. For instance, with increasing electric currents, the same solution can bring about reversals of the deflection, as shown in

TABLE IV.—Potassic Cyanide Solution 4/1000.

Amperes	0·005	0·010	0·020	0·030	0·040	0·050
Double deflection	+4	+6	+2	−9	−21	−26

Table IV. In this case the self-polarisation is positive, and with small electric currents the globules move, as usual, towards the negative pole. If the deflection of the jet, in the case of greater currents, is reversed, it can only mean that the Lippmann curve is asymmetric.

Amalgams.

In the place of pure mercury, Christiansen next proceeds to examine amalgams; for example, zinc amalgam. To obtain this a zinc rod is dipped for a moment into the mercury. The vessel A B fig. 9, is filled with dilute sulphuric acid. With pure mercury the fall of the globules is towards the negative electrode. Let the zinc rod be now dipped into the mercury reservoir. After a short time, *i.e.*, when the zinc has travelled to the jet, the mercury falls plumb; the line of globules then bends a little towards the anode, and then again to the cathode, but finally inclines permanently towards the anode. The explanation is easy when it is remembered that, according to Nernst, zinc amalgam gives positive ions to the solution, and itself becomes negative, so that the self-polarisation of the amalgam is negative. In dilute solutions of hydrochloric acid, nitric acid, and potassium salts, the same results are obtained as with sulphuric acid. But in solutions of zincic sulphate there is little or no deflection, which is explained by there being no self-polarisation in this case. Amalgams of K, Na, Ba, Mg, Mn, and Cd, behave similarly to zinc amalgam. A further experiment was performed by Christiansen. Around the end, G, of the jet (fig. 9) was wound a platinum sheet connected to the platinum wire K. A second platinum wire, J, is fused into the glass tube, G. If H is now made the anode, and if a potential difference of a few volts is maintained between the platinum sheet and the mercury in the tube G, across an electrolyte consisting of a metallic salt, the metal is deposited upon the mercury. By this means the line of falling globules can be made to alter its form, as in the above experiments. There are, however, occasional singularities which leave a doubt as to whether or not it is safe to assume that a metal is never polarised in its own salt.

ON THE CIRCLE-DIAGRAM OF THE REPULSION MOTOR.

Containing a General Method of Deducing the Graphic Theory of any Alternating Current Apparatus.

By F. CREEDY, A.C.G.I.

II.—Application to the Repulsion Motor.

The repulsion motor consists of a stator, which we must assume to be built like that of an induction motor, with an air-gap equal all round the circumference; and a rotor, wound like the armature of a direct-current machine, and fitted with a commutator and brushes, which are placed at a certain angle with the axis of the stator winding, and short-circuited.

Let λ be the angle between the plane of the armature coil and the direction of the stator flux (fig. 6).

Let $\mathbf{i}$ be the R.M.S. stator current.
" $\mathbf{i}_1$ " rotor current.
" $\mathbf{e}_0$ " primary impressed E.M.F.
" z_0 " " exciting impedance.
" z " " impedance (due to resistance and leakage only.)

Let z_1 be the secondary impedance.

z_0, z and z_1, whose meaning was fully explained in the preliminary article, are here assumed constant.

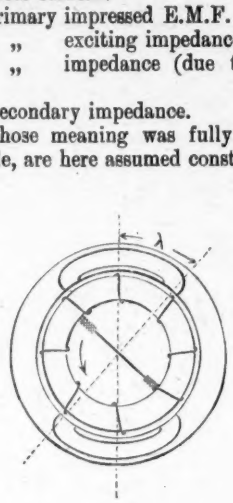


Fig. 6.

The secondary quantities defined above are all supposed to be reduced to the primary circuit in the following manner:—

Let $w = \frac{n}{n_1}$ be the ratio of primary to secondary turns.

If $\mathbf{i}_1'$ = actual secondary current, $\mathbf{i}_1 = \frac{\mathbf{i}_1'}{w}$.

r_1' = " " resistance, $r_1 = w^2 r_1'$.
x_1' = " " reactance, $x_1 = w^2 x_1'$.

Let us now consider what occurs in the stator or primary. In fig. 7 is given a phase diagram drawn to scale in which all the quantities mentioned below are shown. The resultant flux cutting the stator or primary is that due to $\mathbf{i}_0 = \mathbf{i} + \mathbf{i}_1 \sin\lambda$. The E.M.F. consumed, in the stator, by the current $(\mathbf{i} + \mathbf{i}_1 \sin\lambda)$ is $\mathbf{e} = (\mathbf{i} + \mathbf{i}_1 \sin\lambda)\, z_0$.

We have also the E.M.F. consumed by stator impedance $= \mathbf{i}\, z$. The sum of these must be equal to the primary impressed E.M.F.

Therefore $$\mathbf{e}_0 = (\mathbf{i} + \mathbf{i}_1 \sin\lambda)\, z_0 + \mathbf{i}\, z \qquad (1)$$

The simplest way to find out what occurs in the rotor, or secondary, seems to be to consider the E.M.Fs. set up by the

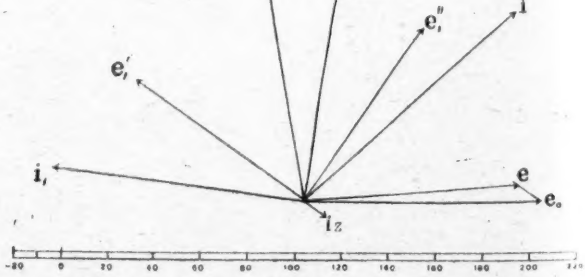


Fig. 7.

(ideal) fluxes due to the stator and rotor currents respectively.

The flux due to the stator current produces in the rotor two E.M.Fs. The first of these $\mathbf{e}_1'$ is set up as in a transformer by the flux of mutual induction between the rotor and stator coils. Thus we have $\mathbf{e}_1' = -\mathbf{i}\, z_0 \sin\lambda$, lagging 90° behind the flux, and proportional to the frequency.

The second $\mathbf{e}_1''$ is produced as in a direct current machine by the revolution of the rotor in the field due to $\mathbf{i}\cos\lambda$. It is in phase with this field and proportional to the speed.

Since at synchronous speed the rotor conductors cut this field at the same rate at which the flux of mutual induction due to $\mathbf{i} \sin\lambda$ cuts them, at this speed these two E.M.Fs. will bear the same ratio to one another, as do the fluxes producing them.

Consequently, we shall have $\mathbf{e}_1''$ of the same magnitude as $-\mathbf{i}\, z_0 \cos\lambda$, but leading it by 90°. The expression for it is therefore $\mathbf{e}_1'' = \mathbf{i}\, z_0\, j \cos\lambda$ (since multiplication by $-j$ produces a lead of 90°). Since $\mathbf{e}_1''$ is proportional to the speed, at any other speed the expression for it will be $\mathbf{i}\, z_0\, j\, k \cos\lambda$ where k = speed/synchronism. The sum of these two E.M.Fs. $\mathbf{e}_1 = \mathbf{e}_1' + \mathbf{e}_1''$ must be equal to the total E.M.F. consumed by the rotor current $\mathbf{i}_1 (Z_0 + Z_1)$.

Therefore

$$\mathbf{e}_1 = \mathbf{i}_1 (Z_0 + Z_1),$$

or
$$-\mathbf{i}\, z_0 (\sin\lambda - j\, k \cos\lambda) = \mathbf{i}_1 (Z_0 + Z_1) \qquad (2)$$

These two equations, together with the general expressions for the power, torque, &c., of any alternating current apparatus, implicitly contain the whole theory of the repulsion motor.

Deduction of the Current Circle.—From equation (1)

$$\mathbf{i}_1 = \frac{\mathbf{e}_0 - \mathbf{i}\,(Z_0 + Z)}{Z_0 \sin\lambda}.$$

Substituting in (2), rearranging, and dividing by z_0,

$$\mathbf{i}\left(\sin\lambda - \frac{(Z_0 + Z)(\bar{Z}_0 + \bar{Z}_1)}{Z_0^2 \sin\lambda}\right) + \mathbf{e}_0 \frac{\bar{Z}_0 + \bar{Z}_1}{Z_0^2 \sin\lambda} = \mathbf{i}\, j\, k \cos\lambda.$$

(We must be careful to distinguish between Z_0^2, a complex number, and $z_0 \bar{z}_0 = z_0^2$, a real quantity, the square of the magnitude of Z_0.)

This equation may be written—

$$\mathbf{i}\, A + \mathbf{e}_0\, B = \mathbf{i}\, j\, k \cos\lambda. \qquad (3)$$

We may treat this equation in two ways, each of which gives important results.

Multiplying by $\bar{\mathbf{i}}$, and taking only the real part of the product, we get

$$i^2 [A]_1 + [\bar{\mathbf{i}}\, \mathbf{e}_0\, B]_1 = 0.$$

(Since $\mathbf{i}\,\bar{\mathbf{i}} = i^2$ is real, the right-hand side is pure imaginary). Dividing by $[A]_1$ we get—

$$i^2 + \left[\bar{\mathbf{i}}\, \mathbf{e}_0 \frac{B}{[A]_1}\right]_1 = 0.$$

Factorising and writing $2\mathbf{c} = -\mathbf{e}_0 \frac{B}{[A]_1}$,

$$[\bar{\mathbf{i}}\,(\mathbf{i} - 2\mathbf{c})]_1 = 0. \qquad (4)$$

This equation asserts that the projection of $\mathbf{i}$ on $(\mathbf{i} - 2\mathbf{c})$ is zero, that is, that $\mathbf{i}$ is perpendicular to $(\mathbf{i} - 2\mathbf{c})$. Thus (see fig. 8) $\mathbf{i}$ must move on a circle of diameter $2\mathbf{c}$.

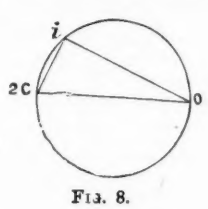


Fig. 8.

Since $\mathbf{i} = 0$ satisfies the equation, the circle must pass through the origin.

Treating equation 3 in a different way, we have

$$k = \frac{\frac{A}{j\cos\lambda}\left(\mathbf{i} + \mathbf{e}_0 \frac{B}{A}\right)}{\mathbf{i}}.$$

Let us put $\frac{A}{j\cos\lambda} = d \operatorname{cis}\gamma$* and divide by d. We then get

$$k/d = \frac{\operatorname{cis}\gamma\left(\mathbf{i} + \mathbf{e}_0 \frac{B}{A}\right)}{\mathbf{i}} \qquad (5)$$

From this equation we may make several important conclusions :—

1. $\operatorname{cis}\gamma$ is a mere turning factor, which makes no difference to the length of the vector $\left(\mathbf{i} + \mathbf{e}_0 \frac{B}{A}\right)$.

* $\operatorname{cis}\gamma$ is short for $(\cos\gamma + j \sin\gamma)$.—See preliminary article.

Therefore the speed which is proportional to k/d is the ratio of the length of $\left(\mathbf{i} + \mathbf{e}_0 \frac{B}{A}\right)$ to the length of $\mathbf{i}$.

Thus in fig. 9 if $\overline{0S} = -\mathbf{e}_0 \frac{B}{A}$ the speed is $\frac{SI}{0I}$.

2. Putting $k = 0$ we get $\mathbf{i} = -\mathbf{e}_0 \frac{B}{A}$, therefore, the standstill current $\mathbf{s} = -\mathbf{e}_0 \frac{B}{A}$.

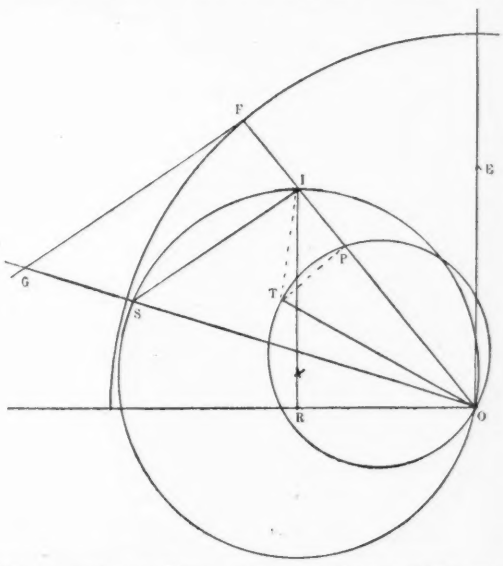
We can also get from equation 5 another proof that $\mathbf{i}$ moves on a circle.

We can represent the speed by a single line in the following manner :—Draw a circle of any radius, with O as centre (see fig. 9). Through the point F where O I (produced if necessary) cuts this circle, draw a line parallel to I S cutting O S (also produced if necessary) in G.

Since the triangles O I S and O F G are similar,

$$\frac{GF}{0F} = \frac{SI}{0I},$$

but O F is constant. Therefore the speed is measured by G F.



Primary current = O I; Torque = O I . I P; Speed = F G; Input = I E; Output = S I . I P.

Fig. 9.—The Circle Diagram of the Repulsion Motor.

Torque.—The torque of any electric motor, taken in suitable units, is equal to the product of the secondary ampere-turns into that component of the flux, which is in phase with the secondary current in time, but at right angles to it in space.

In the motor under consideration we have an E.M.F. in phase with the above flux and proportional to it. This E.M.F. is produced by the rotation of the armature at any constant speed (say synchronism) in that part of the field (due to $\mathbf{i} \cos\lambda$), perpendicular to the brush-line. At synchronous speed, the expression for this E.M.F. is

$$\mathbf{e}_1'' = \mathbf{i}\, j\, z_0 \cos\lambda.$$

If we take $[\mathbf{i}_1\, \bar{\mathbf{e}}_1'']_1$, the product of the secondary current, into that component of the above E.M.F. which is in phase with it (see definition) to represent the torque, we get it in what Steinmetz calls "synchronous watts," or the watts output which the motor would give, if, with the same torque, it ran at synchronous speed.

Consequently,

$$\text{Torque} = \cos\lambda\, [\mathbf{i}_1\, \bar{\mathbf{i}}\, \bar{j}\, \bar{z}_0]_1.$$

From equation (1)

$$\mathbf{i}_1 = \frac{\mathbf{e}_0 - \mathbf{i}\,(Z_0 + Z)}{Z_0 \sin\lambda}.$$

Substituting

$$T = \cot\lambda \left[\bar{\mathbf{i}}\left(\mathbf{i}\,(\bar{Z}_0 + \bar{Z}) \frac{j\bar{z}_0}{z_0} - \mathbf{e}_0 \frac{j\bar{z}_0}{z_0}\right)\right]_1$$

(since $\bar{j} = -j$),

or
$$T \tan\lambda = [\bar{\mathbf{i}}\,(\mathbf{i}\, G - \mathbf{e}_0\, H)]_1$$

multiplying out, $T \tan\lambda = i^2 [G]_1 - [\bar{\mathbf{i}}\, \mathbf{e}_0\, H]_1$

dividing by $[G]_1$

$$T \tan \lambda / [G]_1 = i^2 - \left[\bar{i} \frac{e_0 H}{[G]_1} \right]_1 .$$

Substituting $t = e_0 \frac{H}{[G]_1}$, and factorising again, we get

$$T \tan \lambda / [G]_1 = [\bar{i} (i - t)]_1 \quad (6)$$

This means, graphically, that to a certain scale the torque may be represented by the product of the length of the current-vector into the projection of the vector $(i - t)$ upon it or (see fig. 9) if O T = t by O I . I P.

Now, since the angle O P T is always a right angle whatever i may be, and O T is a constant vector, the point P moves on a circle with O T as diameter, consequently we get the construction of fig. 9 where the torque is represented by the product of the length of the current-vector into its intercept between the two circles O P T and O I S.

This circle (viz., O P T) is independent of λ, as can easily be seen, but the scale to which O I . I P represents the torque, changes with λ. To find this scale is very easy if we know the unit of torque for one value of λ. It can be seen from equation 6 that the torque (other things equal) is proportional to cot λ.

Consequently, the *torque scale* is proportional to tan λ. Therefore, if in fig. 10, A B is our unit of torque when cot λ

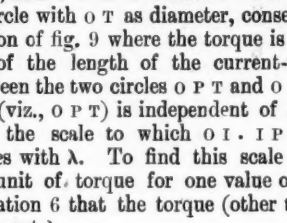


Fig. 10.

= 1, or λ = 45°, and we set off a right angle at B, and an angle of λ at A, thus obtaining the triangle A B C, we have B C = A B tan λ.

Therefore B C is the unit of torque for any other value of λ.

(To be continued.)

NEW PATENTS APPLIED FOR, 1904.

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2,397. "The renewable centre and self-lubricating trolley pulley for overhead electric tramcars and the like." R. Carnegie and A. Beevers. February 1st.

2,420. "Improvements in trolleys for electric cars." W. A. Daggett. February 1st. (Complete.)

2,433. "Improvements in means for regulating dynamos." H. Leitner and R. N. Lucas. February 1st.

2,434. "Improvements in secondary batteries." H. Leitner. February 1st.

2,438. "Improvements in automatic electrical switches." A. S. Adler. February 1st. (Complete.)

2,450. "Improvements in controlling electric switches." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,452. "Improvements in alternating-current electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,453. "Improvements in alternating-current electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,454. "Improvements in combined circuit-breakers and starting rheostats." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,455. "Improvements in control of alternating current electric motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,456. "Improvements in machines for treating filaments for electric lamps." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 1st.

2,458. "Improvements in brush-holders for dynamo-electric machines." H. M. Acly. (Date applied for under Patents Act, 1901, January 31st, 1903, being date of application in United States.) February 1st. (Complete.)

2,466. "Improvements in clockwork electricity meters." H. Aron. February 1st. (Complete.)

2,467. "Improvements in clockwork electricity meters." H. Aron. February 1st. (Complete.)

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2,496. "Apparatus for producing oscillatory currents." P. C. Hewitt. (Date applied for under Patents Act, 1901, February 9th, 1903, being date of application in United States.) February 1st. (Complete.)

2,497. "Improvements in controllers for electric motors." M. Cummins. February 1st.

2,504. "An improved contact shoe for electric railways." H. Rosenfeld. February 1st. (Complete.)

2,512. "Improvements in electrical joint boxes." W. E. Groves. February 2nd.

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2,581. "Improvements in machines for making stems for incandescent lamps." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) February 2nd.

2,582. "Improvements in synchronism indicators." The British Thomson-Houston Co. (The General Electric Co., United States.) February 2nd.

2,583. "Improvements in and relating to insulation of electrical conductors." E. Bergtheil. February 2nd.

2,602. "Improvements in interchangeable electric display apparatus." D. Levy. (Date applied for under Patents Act, 1901, February 10th, 1903, being date of application in United States.) February 2nd. (Complete.)

2,614. "Improvements in terminals for electric batteries." H. G. Prested. February 2nd.

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3,000. "Improvements in controllers for electric motors and other apparatus." G. Laird and J. P. Todd. February 6th.

3,010. "Improvements in electric traction on a road contact or like system." C. J. Ross and B. C. Matthews. February 6th.

3,029. "Improvements in or relating to connections or connecting pieces for electricity conductors." H. Hirsch. February 6th. (Complete.)

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